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# JPRS Report

# Science & Technology

## USSR: Space

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## Cosmonauts Prepare for 25 Jun EVA

*LD1406091491 Moscow TASS in English 0851 GMT 14 Jun 91*

[Text] Moscow June 14 TASS—Soviet Cosmonauts Anatoliy Artsebarskiy and Sergey Kirkalev on board the orbital research complex Mir have performed several series of experiments on the Krater and Kristallizator technological installations to measure microaccelerations that influence the processes of growing crystals of various substances in orbital flight conditions, a spokesman at the Mission Control Center told TASS.

Today the cosmonauts will carry out a vibroseismograph experiment on the Optizon installation, the spokesman added.

In accordance with the station's flight schedule, the cosmonauts adjusted the station's orbit twice by using the Progress M-8 spaceship motors.

Artsebarskiy and Krikalev began preparations for a spacewalk. They have undergone a preliminary medical check-up and are today trying out operations that they will peform on the outer surface of the orbital complex on June 25.

## Cosmonauts Continue Experiments, Deploy 'Mak-1' Satellite

*LD1706191891 Moscow TASS in English 1403 GMT 17 Jun 91*

[Text] Moscow June 17 TASS—Soviet cosmonauts Anatoliy Artsebarskiy and Sergey Krikalev continue work on board the Mir space station, TASS was told at the Mission Control Center.

In the past few days, they used the magnetic spectrometer Mariya to carry out a series of experiments to obtain data on the interaction of high-energy space particles with the earth's radiation belts.

Experiments also continued with the help of the space greenhouses Vazon and Svetoblok to study the development of plants in zero gravity.

According to the schedule of work with the Progress M-8 ferry spacecraft, the fuel tanks of the station's joint engine installation were replenished. Today, the cosmonauts plan to pump drinking water from the ferry into the station's water tanks.

A small autonomous satellite, Mak-1, was launched from the Mir station on June 17 at 05:58 Moscow time to study earth atmosphere properties.

## Cosmonauts Stress Benefits of Space Research at Post-Flight News Conference

*PM1806145391 Moscow Central Television First Program Network in Russian 1800 GMT 14 Jun 91*

[From the "Vremya" newscast: Report by A. Gerasimov and V. Dolina, identified by caption]

[Text] [Announcer] Post-flight medical checks were completed today on the Soviet-British space crew.

[Gerasimov] The Soviet Center for Cosmonaut Training is particularly proud of its methods for preparing crews for long space missions. It is thanks to them that the Soviet cosmonauts who worked in Earth orbit for almost half a year have fully readjusted in a matter of a few weeks to conditions on Earth—not only physiologically, but also in a political and material sense.

After all, in the past six months much has changed in our country, including the attitude of the press toward space flight. Neither Soviet nor English journalists came to today's news conference.

How were you welcomed back in England?

[Helen Sharman] Nowadays many people are interested in space. They are now realizing what you have probably known for some years.

[Gerasimov] The Soviet cosmonauts are concerned about questions of a more practical nature.

[Viktor Afanasyev] It has to be profitable. We conduct experiments. Many materials that we obtain in space cannot be produced on Earth. This is impracticable in view of the funds that would have to be spent to obtain such materials or technology for the production of such materials on Earth—many of them simply could not be produced, and many would require major expenditure.

[Musa Manarov] We have demonstrated, for instance, that with the constant presence of television equipment we can film what is happening directly in any situation and transmit it from space.

At the moment, we could see, for example, the current state of the eruption of the volcano, which we could show since it is more clearly visible from space.

[Gerasimov] Unfortunately, it is not only volcanic smoke that is observed from orbit. This is what Kuwait looks like to Anatoliy Artsebarskiy and Sergey Krikalev aboard the Mir station. Giant plumes of smoke from burning oil wells stretch almost as far as the Indian Ocean. The scale of the ecological catastrophe is shocking. It is only from space that its global extent can be truly appreciated.

Incidentally, the United Nations has voiced gratitude to Musa Manarov and Viktor Afanasyev for showing the course of events during the Iraq-Kuwait war from orbit. So there is plenty to do in space for the benefit of the Earth. The space vigil continues.

## Cosmonauts Begin First EVA

*LD2406214791 Moscow TASS in English 2122 GMT 24 Jun 91*

[by TASS correspondent Rena Kuznetsova]

[Text] Moscow June 25 TASS—Soviet cosmonauts Anatoliy Artsebarskiy and Sergey Krikalev have just begun extravehicular activities.

Artsebarskiy and Krikalev—the crew of the ninth main expedition—have been working on board the orbital complex Mir for the second month.

The principal aim during their first spacewalk is to replace the antenna which ensures the guidance and docking of a spaceship with the orbital complex and which is installed on the astrophysical module Kvant.

Artsebarskiy and Krikalev are expected to stay outside the orbital station for more than five hours.

## Experimental Girder Installed

*LD2506082891 Moscow TASS in English 0702 GMT 25 Jun 91*

[Text] Moscow June 25 TASS—Cosmonauts Anatoliy Artsebarskiy and Sergey Krikalev spent five hours in space Monday night, replacing an antenna on the Kvant module docked with the Mir space station.

The cosmonauts opened the hatch of the Mir station at [figures indistinct] Moscow time and replaced the antenna system with a new one delivered by the progress M-8 cargo space ship.

They also installed an experimental girder designed to evaluate the efficiency of thermomechanical compositions during the erection of large structures in open space on the Kvant-2 module.

The crew spent a total of four hours 58 minutes in open space. Both Artsebarskiy and Krikalev are feeling well after the spacewalk, doctors said.

## Antenna Replacement Completed Successfully

*LD2506053491 Moscow All-Union Radio Mayak Network in Russian 0430 GMT 25 Jun 91*

[Text] Today our cosmonauts Anatoliy Artsebarskiy and Sergey Krikalev have been working in open space all night. They spent five hours outside the station, and replaced the antenna which ensures the approach and docking of the cargo craft with the orbital complex. The cosmonauts have already taken their suits off, and are currently working inside the station.

## Replacement of Damaged Antenna Described

*PM2506200591 Moscow IZVESTIYA in Russian 26 Jun 91 Union Edition p 1*

[S. Leskov report: "Troubled Night On Board Mir"]

[Text] Cosmonauts A. Artsebarskiy and S. Krikalev spent the night of 24-25 June in open space. The crew was tasked with performing the highly complex job of replacing the disabled antenna on the "Kurs" system.

The following indicates the labor-intensiveness of this job. A few days ago during a control run-through of the spacewalk in the Star City [simulation] pool it took testers a whole hour just to find a suitable position on the ship's hull. Yet that only represents the preparation for the main job, which is expected to take six hours. Snatches of film taken in the pool were relayed on board and served as a guide for the crew.

What happened to the "Kurs" system's antenna which is designed to ensure spacecrafts' automatic approach and docking with the Mir orbital station? The last few spacecraft have had great difficulties docking with Mir. It is being surmised that the antenna was damaged by the previous crew during their spacewalk. However, it would be unfair to reproach Afanasyev and Manarov for inefficiency. The work was, after all, carried out in a terribly confined space with the elements of the complex positioned in a totally different configuration from that envisaged according to the program.

The nocturnal work required truly intricate skill in manipulating the unique, specially developed tool [slesarnyy instrument]. Suffice it to say that even a tiny mirror similar to that used by dentists was put into service. The damaged parts of the antenna were stripped down and the new antenna mounted in a room [zal] containing, according to O. Tsygankov, chief of the "Energiya" Science-and-Production Association experimental test department, roughly 10 instruments—some of them of vital importance, moreover. This crew had not, after all, had occasion to work in open space before. Central Flight Control strictly recommended that Artsebarskiy and Krikalev not move around the complex when darkness fell during the orbit and not perform even minor operations in shadow, using this time for rest.

It is sad that we have of late referred to the Mir orbital complex and the crews living in space almost exclusively in connection with repair work. No one will argue that it is taking ever-increasing effort to maintain the aging orbital complex. Yet it has still not been fully equipped....

This spacewalk ended safely, the crew carried out their mission. But Artsebarskiy and Krikalev are to go into open space another eight times—a record achievement for the cosmonauts.

## Cosmonauts Complete Seventh Week of Flight

*LD0507131591 Moscow TASS in English 1243 GMT 5 Jul 91*

[Text] Moscow July 5 TASS—Cosmonauts Anatoliy Artsebarskiy and Sergey Krikalev are ending the seventh week of their space flight on board the Mir space station.

On Wednesday and Thursday, they were involved in astrophysical and geophysical research and conducted technical experiments.

With the help of the Mariya magnet spectroscope, they have completed another series of experiments aimed at finding possible ties between the intensity of elementary charged particle flows near the Earth and seismic activities on the planet.

The cosmonauts also conducted experiments on a vibroseismographer to obtain data about the influence of microacceleration on technological processes on board the station.

Today, the crew is preparing equipment for future work.

According to a medical examination on Thursday, Artsebarskiy and Krikalev are feeling well.

## Cosmonauts Conduct Astrophysical Experiments

*LD0907151991 Moscow TASS in English 1427 GMT 9 Jul 91*

[Text] Moscow July 9 TASS—Cosmonauts Anatoliy Artsebarskiy and Sergey Krikalev continue their mission aboard the "Mir" complex.

Under the flight program, the crew carried out a series of astrophysical experiments using devices "Buket", "Granat", and "Mariya". The cosmonauts took measurements of the space and energy characteristics of cosmic radiation in various bands of wavelengths and examined interaction of the floods of elementary charged particles of high energy with the earth's radiation band.

To continue research on the earth's atmosphere the "radio scanning" experiment was conducted.

The tanks of the station's united propulsion system were refuelled with the oxidizing agent brought by the progress M-8 cargo spacecraft.

Artsebarskiy and Krikalev will spend the next few days preparing for next week's spacewalk.

Radio sessions with the crew and telemetric data indicate that the flight proceeds normally.

## Briefing on 'Sofora' Girder Experiment

*LD1007213991*

[Editorial report] Moscow Central Television First Program Network in Russian, in its "Vremya" newscast at 1800 GMT on 10 July, carries a two-minute video report by correspondent A. Gerasimov on a news briefing at the flight control center near Moscow today regarding an experiement to be conducted soon aboard the Mir space station.

Gerasimov begins his report by showing computer graphics of the planned American "Freedom" space station. The components of the station are to be assembled in space. He then shows a blueprint and a model of an existing Soviet girder assembly that can be used to build things in space and which will be attached to the Mir station this month. The blueprint is headed "SOFORA experiment". Gerasimov manipulates a number of tubular metal structures with attachments that slot into place. A 14-meter girder will be assembled by cosmonauts Krikalev and Artsebarskiy according to a unique design. The components are attached to one another by "elegant" couplings or sleeves [muftami] "made of materials with a memory effect". The operation will require four spacewalks to assemble and mount this "space wing". The video shows a lengthy girder assembly being manipulated by a cosmonaut or by someone in a weightlessness flight simulator.

Next shown on screen is a box-like structure consisting of rows of tubes with nozzles which is described as "Sofora", an "orbiting electronic fitting complex". Sofora's next task is to act as a support bar [Shtanga] for an additional steering motor for the space station. An extravehicular activity is to take place on 15 July. It is hoped that, once tested, this assembly technology can be used to earn money by assembling other nations' space projects in orbit, including those of the United States. The video shows other parts of the equipment.

## Four EVAs Planned for July

*LD1207165591 Moscow Radio Moscow World Service in English 1200 GMT 12 Jul 91*

[Text] Soviet cosmonauts Anatoliy Artsebarskiy and Sergey Krikalev working on the orbital complex Mir will make four space walks this month.

The first one will be on Monday. The crew is to assemble a 14 meter-long structure and this will require no welding or bolting. The structure is made of alloys that memorize the original form. On Earth their diameter changes with the use of special technology and in space the same elements when heated remember, so to say, their original forms and join together solidly.

## Mir Cosmonauts Prepare for 19 July EVA

*LD1807140191 Moscow All-Union Radio Mayak Network in Russian 1200 GMT 18 Jul 91*

[Excerpts] Cosmonauts Anatoliy Artysebarskiy and Sergey Krikalev have been working in space for exactly two months. They will be carrying out a record number of EVAs during their flight. This is not because they are chasing records, but because they are carrying out a very important experiment in building new large structures on the station's exterior which are to become elements in the next generation of orbital complexes. [passage omitted]

Tomorrow Anatoliy Artsebarskiy and Sergey Krikalev will again set off to work in open space. This is something we have become used to, but for American astronauts there has been an interval of five years since they last did this kind of work.

## Cosmonauts Begin Fourth EVA

*LD1907121391 Moscow All-Union Radio Mayak Network in Russian 1134 GMT 19 Jul 91*

[Excerpts] A few minutes ago, cosmonauts Anatoliy Artsebarskiy and Sergey Kirkalev started working in open space again. As we have promised, here is a report from the Flight Control Center by our correspondent Vladimir Bezyayev.

[Bezyayev] Good afternoon, dear comrades. [passage omitted] The cosmonauts opened the hatch 15 minutes earlier than scheduled, while they were outside the visibility zone of the Soviet Union. This shows that many things have become routine; crews are gaining more trust, and they plan their operations themselves. So this is the fourth EVA [Extravehicular Activity] for this crew, and the second within the framework of the Sofora experiment for erecting large-dimension structures on the outer surface of the station. [passage omitted]

## Coamonauts Begin Assembly of 'Sofora' Girder

*LD1907205491 Moscow TASS in English 1953 GMT 19 Jul 91*

[By special correspondent from the Space Mission Control Center]

[Text] Moscow July 19 TASS—Soviet cosmonauts Anatoliy Artsebarskiy and Sergey Krikalev today carried out a regular phase of work under the program of the Sofora experiment.

They began to assemble a 14-meter-long truss structure on the outer surface of the orbital complex Mir.

The crew began the spacewalk at 1410 Moscow time. The cosmonauts took structural elements and equipment intended for assembly from the airlock compartment and by means of a telescopic jib shifted them to the astrophyscial module Kvant.

Then on a platform installed during the previous spacewalk, the cosmonauts fixed an erection site and building ways that are necessary for the fixation of the structural elements of the tower of trusses during the assembly process.

The first section of the truss tower, pre-assembled by the cosmonauts inside the orbital complex, was inside the building ways.

During further work in open space, the mission commander and flight engineer assembled two more sections. The formation of rigid permanent joints was ensured due to the heating of the couplings of thermomechanical joints by means of four assembly-and-heating devices.

The two cosmonauts worked in outer space for five hours and 28 minutes.

The next phase of the Sofora experiment will be carried out on July 23.

## EVA Preparation Described, Further Comments on 'Sofora'

*PM2607104791 Moscow Central Television Second Program in Russian 0545 GMT 20 Jul 91*

[From the July edition of the "Man, Earth, Universe" program hosted by USSR Pilot-Cosmonaut V.I. Sevastyanov]

[Text] [Sevastyanov] Dear friends! Work is under way in space. Constant work is under way in space. There are periods of high intensity in this work, and periods when the work of the cosmonauts aboard the Mir scientific orbital complex is more relaxed. It is during these periods that they prepare for new scientific work.

Over the past six weeks our colleagues, Cosmonauts Sergey Krikalev and Anatoliy Artsebarskiy, have carried out two very important spacewalks to repair part of the equipment on the outside of the complex and to install new equipment. During the second spacewalk they performed so well that they were able to cut the extravehicular activity [EVA] by two hours while carrying out all the set tasks. An excellent result! How is this possible? It is possible because the cosmonauts prepare very thoroughly for the EVA's. I would now like to show you a segment of the crew's preparation for an upcoming EVA. It will show you how, exchanging information with mission control, they are assembling the girder and some units from components sent up from the ground in order to subsequently mount them outside. The cosmonauts record all this on a videotape—the communications sessions with the ground are relatively short, limited to the time when the crew is overflying the territory of our country—so they record everything, subsequently transmitting all this information to specialists on the ground, and the specialists introduce corrections and provide advice.

[Fragmented and largely unintelligible interchange between cosmonauts and ground control is heard.]

I could also show you different pictures in which you would see the same structure. Let me remind you, on 15 July the cosmonauts spent five hours and 56 minutes in open space—as long as five hours and 56 minutes—and several more EVA's are scheduled. And they are all based on hours, days, and weeks of preparatory work, like the work which you are seeing now. There is no escaping this work. Painstaking, (detailed), and often tiresome work. A spacewalk is like a stage performance. Yet how much

work is necessary backstage, before (the curtain goes up)? [lengthy indistinct exchange] But there is no other way, either on the ground or in space. This is the only way to achieve success.

The experiment itself is named Sofora, after a shrub which grows in the Ukraine, the Caucasus, and Central Asia. Exactly why, I do not know. A Sofora has been planted on a platform on the Kvant module, and it will grow to a height of 14 meters; I mean the girder. That is as high as a five-story apartment building. And it will be subjected to burning frosts and radiation and will be bathed in cosmic rays. It will be left alone for a whole year with only its sensors for company. Will it survive? Will it put down roots? You have seen for yourself what a fragile-looking structure this Sofora is.

## TV Coverage of 'Sofora' Assembly, Financial Problems Noted

*LD1907221591 Moscow Central Television First Program Network in Russian 1800 GMT 19 Jul 91*

[Video report by A. Gerasimov from Flight Control Center; from the "Vremya" newscast]

[Text] Our cosmonauts have been working today on the outside of the station. Let me remind you that the world's first spacewalk took place on 18 March 1965 and was made by Cosmonaut Aleksey Leonov. It now seems that building work in space makes progress more quickly than on earth. [video shows control room at Flight Control Center, then long shots from external camera of cosmonauts working outside of spacecraft, mixed with close-ups and medium shots of the same equipment being assembled in a zero-gravity simulator]

[Gerasimov] Whereas on earth there is a strict rule that one should not stand under the boom of a crane, in space it is quite different. Flight Engineer Sergey Krikalev, acting crane-driver, used the boom to deliver his commander, Anatoliy Artsebarskiy, exactly to the spot where the work was to be done, along with the assembly platform. And while the previous extravehicular activity [EVA] had been used to install the foundation for the Sofora girder structure, today the cosmonauts installed a little assembly facility like this on the Kvant module. It will be used to assemble the elements of the new structure in space. This is just as elegant as the Flight Control Center's attempt to adapt to the new far-from-easy market conditions.

[Flight Director V. Solovyev] Our whole organization and structure for controlling complex space apparatus amounts above all to a data bank and an information processing bank, plus a huge quantity of communications. We are now attempting, on the basis of this data bank, to organize some kind of, let's call it, exchange structure. In that sense maybe—maybe—we can try to raise—well, maybe not raise but actually earn money to continue our work in space. [video shows further shots of EVA and work in simulator]

[Gerasimov] It goes without saying that this is a rather paradoxical situation. What the cosmonauts have been doing in orbit today is unique, dealing above all with new materials and technologies which could be profitably traded. Yet at the same time our leading space firms are forced to earn cash on the side. Who will find a rational way out of this situation?

Anatoliy Artsebarskiy and Seergey Kruikalev are next due to work in open space on 23 July.

## Details of 'Sofora' Space Experiment

*PM2407133591 Moscow IZVESTIYA in Russian 22 Jul 91 Union Edition p 1*

[Report by S. Leskov: "Six Space Walks"]

[Text] Cosmonauts Anatoliy Artsebarskiy and Sergey Krikalev completed a scheduled space walk 17 July. Over the next two weeks they should carry out four more space walks.

All the work outside the Mir orbital station is dedicated to the Sofora experiment. Although Artsebarskiy and Krikalev have been in open space twice before, it has to be recognized that such intensive work outside the spacecraft is still without precedent in the entire practice of outer space exploration.

So what exactly is the Sofora experiment? As A. Chernyavskiy, one of the Sofora experiment's designers and a representative of the "Engergiya" Science and Production Association, told IZVESTIYA's correspondent, the aim of Sofora is to test new methods for assembling large-scale structures in outer space using thermomechanical joints made from materials possessing a shape memory effect. This complex terminology conceals a 14-meter long mast amply equipped with every possible kind of sensor. Already, on more than one occasion, previous crews have built various girder structures in outer space. The main difference with Sofora is that the latest structure will be collapsible, which means that its configuration can be altered if needed.

Furthermore, for the first time in outer space exploration history, advanced materials are being used which are capable of regaining their former shape after heating. It must be said that the work which the cosmonauts are carrying out with these materials could be used for conversion purposes. Already, materials with shape memory effect are being applied in many exclusively Earth-based spheres: For example, stomatologists rely on these materials when correcting teeth. Incidentally, this is the most expensive piece of orthodontic apparatus in the world—10 thin wires cost $59.

When assembling the girder, again for the first time in the history of outer space exploration, the crew is using special heating devices which are inserted into the joints linking the various elements of the giant girder. Previously these elements used to be joined by hinges, but the current method ensures the structure's greater durability.

The designers believe that the girder itself will become the prototype for large-scale girder strucures in future space exploration. Moreover, it is planned to use this mast for purely practical purposes as early as next year. A special unit for fastening an engine installation is attached to the end of the girder, and in view of the 14-meter long span, it will significantly facilitate the control of the orbital complex's massive bulk.

Two space walks are scheduled for 23 and 27 July, during which assembly work for the Sofora experiment will continue.

## 'Sofora' Experimental Stucture Assemby Continued in 23 July EVA

*PM2507160591 Moscow Central Television First Program Network in Russian 1800 GMT 23 Jul 91*

[From the "Vremya" newscast: Report by A. Gerasimov and Ye. Shmatrikov, identified by caption]

[Text] In 75 hours of flight Soviet cosmonauts Anatoliy Artsebarskiy and Sergey Krikalev have made five spacewalks. That's a kind of world record, but, needless to say, the cosmonauts didn't leave their orbital home to set records. Our correspondent reports from the Flight Control Center.

[Gerasimov] At roughly 1800 today when the cosmonauts entered the Mir station it became clear that the onboard reconstruction was coming to an end. In five and a half hours' work in space Anatoliy Artsebarskiy and Sergey Krikalev built a large proportion of the experimental Sofora girder structure—the prototype for the space structures of the future. You can see it in the top of the picture. The already huge space station has considerably increased in size.

Here are the elements from which the Sofora space girder is made. The main feature of the experiment elaborated at the Energiya Science and Production Association is that these two sections are joined by a coupling made from a titanium-nickel alloy which possesses a memory effect. This, essentially, means that, when heated, this material remembers its previous small size and keeps contact with amazing force.

Technologies using memory-effect materials elaborated for use in space structures have already begun to be put to use on Earth—ranging from medical apparatus to drilling installations for oilmen. Regrettably, the introduction of state-of-the-art technology is once again proceeding very slowly.

The frequency with which the crew is working in open space has injected a humdrum element into events. For that reason we tried to look for something unusual, and found it. You will agree that this is a fantastic picture of Anatoliy Artsebarksiy moving along the station on a boom.

The appearance of a flickering light source near the station enlivened the Flight Control Center. What was it? No one could say clearly. Perhaps glare on the television camera? Perhaps not. But we were not distracted from the work performed by the cosmonauts, who assembled 14 of the structure's 20 sections. The intention is to complete the work on 27 July.

## Problem With Fogged Visor Encountered at Conclusion of EVA

*LD2707221991 Moscow Central Television First Program Network in Russian 1800 GMT 27 Jul 91*

[From the "Vremya" newscast]

[Text] Today's working day in open space by Soviet cosmonauts Anatoliy Artsebarskiy and Sergey Krikalev lasted six hours and 49 minutes. Our correspondent reports from Flight Control Center.

[Correspondent A. Gerasimov] The cosmonauts' working day ended with an alarm. The visor on the spacesuit of the crew commander got steamed up when he was on the way back, and Anatoliy found himself in a sort of fog. The flight engineer had to do the last operation for both of them, and then to act as a guide to Artsebarskiy. Fortunately, all ended well, and the cosmonauts are now resting. [Video shows Flight Control Center scenes]

## New Assembly Experiment Planned

*LD2807080491*

[Editorial Report] Moscow All-Union First Program Radio-1 Network in Russian at 1600 GMT on 27 July carries a five-minute report by correspondent Vladimir Bizyayev on the Sofora experiment completed today by the crew of the Mir space station.

He says that "a very important experiment called Sofora was completed today". He explains that a sofora is a miraculous tree which grows very quickly. So this, in principle, was the "salt" of the experiment: To erect, in a very short time, a miraculus large-size assembly on the exterior side of the station. These assemblies will become prototypes and a necessary component of future orbital stations. Solar batteries and enormous aerials for transmitting electric power to earth obtained from, again, enormous solar electric power stations will be installed on these assemblies." [sentence as heard]

Bizyayev continues: "But there is also a lot of work on earth." He explains that shape-memory metal alloys, that is alloys which when heated resume their original size, can be used in stomatology as well as in the automobile industry. "In short, there are many fields for using these alloys".

Bizyayev says: "This was only the first stage. A new experiment will be carried out in approximatley one year's time [with] a complete assembly... this time modules were assembled using sleeves made from these

alloys, next time it will be an assembly which when folded occupies very little space but as soon as it is heated expands to a large size."

He concludes: "The program for this work has changed because there are changes in a future manned program—but this is a topic for a separate report—sooner or later we will come back to this."

## Cosmonauts Complete 'Sofora' Experimental Structure

*PM0108093191 Moscow Central Television First Program Network in Russian 1800 GMT 27 Jul 91*

[From the "Vremya" newscast: Report by A. Gerasimov, V. Safonov, and Yu. Gvozd]

[Text] Today's working day in open space of the Soviet cosmonauts Anatoliy Artsebarskiy and Sergey Krikalev lasted six hours and 49 minutes. Our correspondent reports from the Flight Control Center.

[Gerasimov] It has been said that construction work in space is proceeding faster than on earth. This statement was fully vindicated today. The current crew of the "Mir" orbital complex has taken just over 24 hours to build the 14-meter "Sofora" experimental structure—as high as a five-story house. The reason why construction work in space is progressing faster than on earth is that every installation operation is rehearsed many times before in the laboratory. At the "Energiya" Scientific-Production Association, for example, a special stand simulating weightlessness has been built. This clever structure enables the test workers to work in conditions which closely resemble space conditions. "Sofora" too was assembled many times over on the factory floor before it was dispatched into space. If these methods could be introduced throughout our industry, we would have much to be proud of.

It is not difficult to understand Anatoliy Artsebarskiy and Sergey Krikalev, who, on their own initiative, placed a Soviet flag atop the girder. After all, our country has not totally fallen apart yet and there are still many things which we do better than anyone else in the world.

[Unidentified cosmonaut] Work on the space construction project has been completed. A vast amount of experience has been gained which will unquestionably be utilized in the future. We hope that the problems which exist today—we do not want to speak about them now—will be conquered by reason and common sense and that everything will proceed normally.

[Gerasimov] But the cosmonauts' working day ended with an alert. On the way back the visor on the crew commander's spacesuit steamed up and Anatoliy ended up in a fog, so to speak. The flight engineer had to carry out the last operations for both of them, and then act as guide to Artsebarskiy. Fortunately, all ended well, and the cosmonauts are now resting. The guys have more than two months left in orbit and they may have to go out into open space a couple more times.

## Cosmonauts Continue Mir Experiment Program

*LD0608162791 Moscow TASS International Service in Russian 1050 GMT 6 Aug 91*

[By unidentified correspondent from Flight Control Center]

[Text] Moscow, 6 Aug (TASS)—The work of Anatoliy Artsebarskiy and Sergey Krikalev aboard the Mir orbital complex continues. Experiments to further study the structure of the Earth's atmosphere are being conducted today. This work is being carried out using an electronic photometer to measure the brightness of stars as they set behind the Earth's horizon.

The crew's flight schedule for this week includes geophysical and astrophysical research and work on the science of materials in space.

The cosmonauts have carried out further video filming of northern areas of Kazakhstan to capture up-to-date information on the state of agricultural land prior to the harvest.

Today, the cosmonauts will also prepare the Krater technological furnace for another smelt.

## Mir Cosmonauts Continue Experiments

*LD0908195291 Moscow TASS in English 1231 GMT 9 Aug 91*

[By a special correspondent reporting from the Mission Control Center]

[Text] Moscow August 9 TASS—The crew of the orbital space complex Mir carried out in the past week a series of experiments in two fields of modern space science: geophysics and technology.

The cosmonauts Anatoliy Artsebarskiy and Sergey Krikalev photographed Soviet territory under a program of the study of the earth's natural resources and environment. Today they monitored Kazakhstan regions, assessing the state of that Central Asian republic's crops.

In keeping with a program of space technology, the crew grew another silicon monocrystal, a high-quality semiconductor.

Using the Krater-V electric furnace, they started today a melting process to last 120 hours. The melting is aimed to produce another monocrystal, cadmium sulfide. In the future such materials will be brought to earth for use in microelectronic equipment.

Medical check-ups show that both Artsebarskiy and Krikalev are in good health after two and a half months in orbit.

## Crew Completes Operations With 'Progress M-8'

*LD1308163491 Moscow TASS in English 1403 GMT 13 Aug 91*

[Text] Flight Control Center August 13 TASS—Soviet cosmonauts Anatoliy Artsebarskiy and Sergey Krikalev on board the orbiting platform Mir effectively completed all planned unloading and other operations involving the cargo craft Progress M-8. The space freighter is to be jettisioned from the platform on Thursday night.

The cosmonauts also continued planned space materials studies using equipment known as Pion. The latest experiments aimed to ascertain the influence of dynamic stresses from the platform's operating facilities on the growth of monocrystals of semiconducting materials during spaceflight.

Other experiments concerned samples of structural materials exposed for a long time to raw space.

A medical check demonstrated that both cosmonauts are in good health and feeling well. Artsebarskiy's pulse is 64 beats a minute and Krikalev's, 60 beats. Their arterial pressure is respectively 120 x 80 and 115 x 70 millimetres of the mercury cloumn.

## Balloon Deployment From 'Progress M-8' Fails

*LD1608205491 Moscow Central Television Vostok Program and Orbita Networks in Russian 1530 GMT 16 Aug 91*

[From the "Vremya" newscast]

[Text] The Flight Control Center near Moscow and the crew of the Soviet space station Mir were carrying out experiments in orbit last night. Our special correspondents report on the details.

[Unidentified correspondent] The space truck Progress, having completed its mission, was undocked from the station and directed toward a suitable point for filming. It was expected that the experiment would be very spectacular, but the reality has exceeded all expectations—what has happened in orbit does not require comment. [Video shows silvery balloon inflating unevenly and then collapsing with pieces flying off it; it is then shown floating limply.]

This balloon is a model of the probe which should have been inflated last night in orbit. [Video shows model of balloon in studio.] Of course, the one in space would be about five times larger. This is a light balloon covered with aluminium foil and it would be very easy to observe from Earth. If this experiment were successful, the scientists could get information about the profile of the top layers of the Earth's atmosphere. This is very important for correcting the orbits of space probes. Remember the recent early demise of the Salyut-7 orbital station which frightened half of the planet with its sudden fall. After five or six orbits of the Earth—which is the life-span of the probe—we could have some idea about the meteorite flow and the flow of of technological waste.

[V. Bass, doctor of technical sciences, identified by caption] Space flights have become more dangerous. Before spending such money on expensive programs it is, after all, necessary to predict what will be in space, as I already said, so that we do not collide with, say, our own trash.

[Correspondent] Well, if at first you don't succeed....

[Bass] As we were joking after the unsuccessful flight, we got a flying carpet instead of a balloon. At least it made a successful flying carpet.

[Correspondent] There are no grounds for concern. Today this space flying carpet will burn up while entering the atmosphere. And this morning Progress wreckage has already sunk somewhere in the Pacific.

## 'Progress M-9' Docks With Mir Station

*LD2308170191 Moscow TASS in English 1642 GMT 23 Aug 91*

[By TASS correspondent Rena Kuznetsova]

[Text] Moscow August 23 TASS—A Progress M-9 cargo craft at 3:54 a.m. Moscow time on Friday docked with the Soviet orbiting station Mir in accordance with the schedule.

The craft carries materials, scientific equipment and foodstuffs for the crew of the Mir station and for three cosmonauts whose ship will blast off on October 2, 1991.

Two joint crews, one of which will join Anatoliy Artsebarskiy and Sergey Krikalev, who have been working on-board the station for over three months, are now being trained at the Cosmonaut Training Center.

The Progress also carries a ballistic capsule. The 350 kilogram capsule will bring to earth 150 kilograms of materials produced in space and results of scientific research.

## Cosmonauts Complete Series of Materials Experiments

*LD2708210491 Moscow TASS in English 1416 GMT 27 Aug 91*

[Text] Mission Control Center, August 27 TASS—Soviet cosmonauts Anatoliy Artsebarskiy and Sergey Krikalev have completed a series of experiments on materials studies.

They used a Krater-B furnace to grow a mono-crystal of semiconductor silicon, which is used in microelectronics.

On Tuesday, they continued unloading the Progress M-9 cargo craft and checked equipment to be used for research during a forthcoming Soviet-Austrian joint flight.

The results of the medical examination showed that both cosmonauts are in good health.

### Mir Cosmonauts Continue Experiments

*LD0609162791 Moscow TASS in English 1355 GMT 6 Sep 91*

[Text] Mission Control Center September 6 TASS— For the past two days, two Soviet cosmonauts on board the orbiting platform Mir, Anatoliy Artsebarskiy and Sergey Krikalev, have concentrated on astrophysical research.

Using facilities on the Mir outer surface, they conducted a number of experiments to measure space rays in a wide range of wavelengths and to discover new sources of X-ray within and beyond the limits of our galaxy.

The Gallar plant on the station is about to complete crystallization of a sample of a semiconductor material, zinc oxide.

According to the results of a medical examination, both cosmonauts are in good health.

### Soyuz Flight Cancelled for Economic Reasons

*LD1807154191 Moscow Radio Moscow World Service in English 1200 GMT 18 Jul 91*

[Text] Soviet aerospace officials have cancelled plans for a launch in November of a manned transport spacecraft, Soyuz, as part of the drive for cost saving. However it will be used in a later space mission, the 11th of its kind. But a joint Soviet-Austrian space mission is due to take place in autumn as scheduled.

### Austrian Cosmonaut Mission To Be Combined With Kazakh Cosmonaut Flight

*LD1607154791 Moscow All-Union Radio First Program Radio-1 Network in Russian 1200 GMT 16 Jul 91*

[Excerpts] Cosmonauts Anatoliy Artsebarskiy and Sergey Krikalev have spent six hours outside the Mir orbital complex and carried out a complicated assembly: they fixed a mounting platform on the outer surface of the station, which is to start a new complicated structure. Our observer Leonid Lazarevich interviewed Vladimir Aleksandrovich Shatalov, head of the Gagarin center for training cosmonauts.

[Begin recording] [Lazarevich] Vladimir Aleksandrovich, there are rumors among journalists, which have not yet been officially confirmed, that changes are to take place in the next expedition. It was originally planned that the crew of two cosmonauts, together with an Austrian citizen, is to go into space for a long time. They say that now the head of the crew is to fly... a cosmonaut representing Kazakhstan is to fly and an Austrian cosmonaut, and that Krikalev is to stay and continue his work as a part of the next expedition [sentence as heard].

[Shatalov] We are constantly examining the progress in implementing our space program. We must—it is also our duty—introduce certain corrections in connection with financial restrictions. [passage omitted] Originally two flights were planned. At present, after considering our options and examining thoroughly the program which is to be implemented during the flight with Austrian cosmonauts, and the program which is proposed by Kazakh scientists, we came to the conclusion that probably it is possible and expedient in principle to combine them. They will not harm each other, but will save a significant sum of money for our space activities, and will make it possible to save one more craft and a carrier-rocket to continue the work involving the Mir orbital complex next year.

We are currently studying and working through details of such an option. It is important that neither of this programs suffers. It is important to ensure safety and to secure the implementation of this program at all stages of the flight, and it is important that the work at the station continues at its present pace.

We will probably have to reconsider the composition of the crews, and most probably Krikalev will have to continue his work at the station until the arrival of the next main expedition. These issues have been coordinated with him.

As for implementation of further work on board the orbital complex under the new head of the crew—Volkov, who is to join the station, we have no particular worries and doubts here. Especially since they have already worked together, they have some experience and I think they will be glad to work together for some time on board the orbital complex. Presently this program... its details are being thoroughly examined at all levels. [end recording]

The crew will carry out the next space walk 19 July.

### Cosmonaut Krikalev's Stay in Orbit Extended

*LD1408095291 Moscow TASS in English 0909 GMT 14 Aug 91*

[By TASS correspondent Rena Kuznetsova]

[Text] Moscow August 14 TASS—Soviet spaceflight engineer Sergey Krikalev will not leave the Mir orbiting station with Anatoliy Artsebarskiy after they complete their mission in October, the Soviet Space Center says.

Artsebarskiy and Krikalev have been working on-board the station for almost three months.

The launch of the tenth main expedition with a Soviet-Austrian crew is scheduled for October 2, 1991. The first crew consists of Aleksandr Volkov, Takhtar Aubakirov from Kazakhstan and Franz [Fibek] from Austria.

Aleksandr Viktorenko, Talgat Musabayev from Kazakhstan and Clemens Lothaller from Austria are on the stand-by crew.

Artsebarskiy will return to earth with Kazakh and Austrian cosmonauts after a week of joint work on-board the station. It is not clear as yet who will replace him. The state commission will disclose the name of the cosmonaut before the flight.

This is the first time that a crew includes two space researchers. The Space Center says the decision to combine a Soviet-Austrian commercial flight and a planned expedition with a Kazakh space researcher has been prompted by the need to economise funds.

## 'Stage-Two' Mir Station Plans Discussed

*917Q0146A Moscow KRASNAYA ZVEZDA in Russian 2 Aug 91 First edition p 4*

[Report by Lieutenant Colonel A. Dolgikh: "Let Me Introduce You to 'Mir Stage Two'"]

[Text] **Rumors have begun to circulate recently that the Mir orbiting complex is an unprofitable installation, that it may incur losses, and that it does not "have too long to live." Doubts are being cast on the prospects for our space program, which has already been experiencing a cruel shortage of money. As a result, what was created over the decades by the unbelievable efforts of our fellow countrymen may ultimately perish.**

But all the same, is everything aboard the Mir as bad as some people would have us believe? I recently visited the Salyut Design Bureau of the NPO [scientific-production association] of Experimental Machine Building, which since February 1970 has been engaged in the development of long-term orbital stations (DOS). I met with designers and planners. Naturally I was interested in learning what kind of prospects exist for our long-term orbital stations. I think that everything I learned will be of some interest to our readers.

Thus, the first five Salyut vehicles (the first generation of long-term orbital stations) had a single docking assembly and a relatively short service life. The second-generation vehicles (the Salyut-6 and Salyut-7) had two docking assemblies, and the present Mir vehicle (third generation) has six. As a result it has been possible to "build" a complex, multipurpose station in space that is unique in terms of purpose. And today such a station has been created.

The Mir orbital complex, which inherited its name from the basic module, is equipped with various space apparatuses. These are primarily the Kvant and the Kvant-2 and the Kristall. The experienced reader can easily find them on the accompanying illustration. I should note, however, that not everything shown in that illustration is yet in place. In 1992 the Spektr should be docked (the T-shaped appendage below with the solar batteries), and in 1993 the Priroda (the item on the right with the long corrugated battery).

Alas, today there are no mechanisms that last forever, hence the need to conduct regular checks on the operation of the systems. Equipment grows old and wears out and so the cosmonauts must not only conduct experiments, but also carry out repair and renovation work. There is a basis for extending the life of particular assemblies and mechanisms on the station until 1992. However, even the new that replaces the old does not always meet the stringent "space" requirements, so to speak. And this occurs frequently. When economic links are broken, and even the economy itself, there can be no other result.

It is proposed that the Mir will operate until 1994. By that time it will have been in orbit eight years and will require replacement. Work is now underway at the Salyut design bureau and the Energiya NPO to develop a "second-stage" Mir. Outwardly it will differ little from its predecessor. But inside, new equipment will be installed, first and foremost a powerful heat-control system. The fact is that when two or three people are working in space simultaneously everything operates normally, but as soon as two crews "move in" the heat control simply "starts to gasp for breath." The temperature and humidity rise, and this leads to malfunctions. It is also proposed that the new station will have a more powerful computer and gyrodynes that will stabilize the station in a given position. There will undoubtedly be new models of special equipment. In particular it is proposed to install improved technological units to manufacture bioactive substances, biocrystals, semiconductors, and optical glasses. In this way the next step will be taken toward creating orbital factories.

Now, as to how what is planned will be implemented. There are two scenarios. The first is to use the Buran. It will go into orbit, "pick up" the second-stage Mir, which will then already be in space undergoing test checks, and dock it on the nose of the old Mir. Then, with the aid of a manipulator two or three modules (whichever are selected) will be docked with the new Mir. After that, several Progress vehicles will undock the modules whose service life has ended and will de-orbit them into the ocean at a given point.

The second scenario envisages the creation of a station similar to the first-stage Mir, which in the experts' opinion is less expensive and more reliable.

So we can see that the work of space exploration continues here even though there are major problems. Alas, many promising avenues are being closed off in the sphere of space exploration. Funding is being cut back constantly. It is clear where this will lead: to loss of priorities, and with this not only the country's prestige but also major hard currency earnings. In the United States, Japan, France, and a number of other countries, rigorous work is now underway to develop long-term

orbital stations, and enormous sums of money are being spent on it. It is the opinion of foreign experts that orbital stations are capable of generating colossal earnings when used rationally. In the not-too-distant future the Americans, in cooperation with their European partners, will be placing their own "home" in orbit—the Freedom station. It will be a kind of analogue to the Mir.

## Prospects for Mir-2 Station Discussed

*LD1608125691 Moscow Radio Moscow World Service in English 0710 GMT 16 Aug 91*

[Excerpts] The Soviet space station Mir continues its flight manned by a crew of two, Anatoliy Artsebarskiy and Sergey Krikalev. The bulk of the Soviet Union's activities in terrestrial space are associated with the station. But what are the station's prospects? Well to tell uas about that here is our science correspondent, Boris Belitskiy.

[Belitskiy] The Mir space complex today consists not only of the Mir station proper. [passage omitted]

Work is therefore under way on a second stage Mir station. Outwardly it will differ little from its predecessor. But inside it will carry new equipment. For one thing, it will have a more powerful heat regulating system. This is necessary for the following reason. So long as the present Mir station is manned by a crew of two or three all is well. But when there are two crews on board during the station handover period from one crew to another, the thermal regulation system does not cope with its job. Both the temperature and the humidity rise above their normal levels, causing problems.

The new station is also to have a more powerful computer and gyrodines for stabilization purposes. Undoubtedly various research instruments too will be modernized. For example, the devices for producing biologically active substances, biological crystals, and optical glass, and this will be another step toward establishing factories in space.

Let me now speak of the actual operation to replace the present station with a new one. There are now two projects for accomplishing this. One of them would be based on using the shuttle Buran. Buran would be orbited to catch the new Mir station, by then already in orbit. It would then tow the new station and attach it to the front of the old Mir. With the help of a manipulator it would then reattach two or three modules from the old station to the new one. After that several unmanned Progress supply craft would detach the modules due for retirement from the old Mir, and would jettison them in an appropriate part of the ocean.

The second project envisages none of these complicated maneuvers. It simply provides for the establishment of a station similar to the present one, and this in view of most experts would be less expensive and more reliable than the first project.

Well, meanwhile at the end of this year, there's likely to be another flight of the Soviet Shuttle Buran. The second flight, like the first, will be an unmanned flight, but it would involve a docking with the Mir station. The station's crew are to transfer to the Shuttle and test its systems. Our mission is scheduled to last a week.

## Observations of Galactic Center Zone in Range 4-30 keV With ART-P Telescope of 'Granat' Observatory. Preliminary Results

*917Q0088A Moscow PISMA V ASTRONOMICHESKIY ZHURNAL in Russian Vol 17 No 2, Feb 91 pp 99-107*

[Article by R. Syunyayev, M. Pavlinskiy, M. Gilfanov, Ye. Churazov, S. Grebenev, M. Markevich, I. Dekhanov, N. Yamburenko and G. Babalyan, Space Research Institute, USSR Academy of Sciences, Moscow; National Space Research Center, Toulouse, France; Astrophysical Service, Nuclear Research Center, Saclay, France; Space Radiations Research Center, Toulouse, France]

UDC 520.6;524.64

[Abstract] The center of the Galaxy is the most densely populated region in the sky. This paper gives the preliminary results of observations of the center of the Galaxy in the range 4-30 keV with the ART-P X-ray telescope of the Granat observatory in March-April 1990. An X-ray map of a region measuring 1.5 x 2°.1, obtained with an angular resolution of about one minute of arc, contains six sources. One of them, GRS1741.9-2853, was discovered in the course of the observations. A strong variability of the source Sgr A, coinciding with the center of the Galaxy, was discovered. This is evidence that most of the X-radiation directly from the area of the center of the Galaxy at energies greater than 20-25 keV is associated with the source 1E1740.7-2942, located at a distance of 0°.7 from the center of the Galaxy. The observational data obtained with the ART-P telescope, as well as a comparison with the results of earlier observations, show that all six sources are variable. Among the six sources observable with the ART-P, four (GRS1741.9-2853, A1742-294, SLX1744-299/SLX1744-300 and 1E1743.1-2843 have quite soft spectra; Sgr A, closest to the center of the Galaxy, has a relatively hard spectrum; the only source observable to an energy of about 300 keV is 1E1740.7-2942, a possible black hole. Figures 4; references 12: 1 Russian, 11 Western.

## First Results of Observations of X-Ray Pulsars With ART-P Telescope on 'Granat' Observatory

*917Q0088B Moscow PISMA V ASTRONOMICHESKIY ZHURNAL in Russian Vol 17 No 2, Feb 91 pp 108-115*

[Article by M. Gilfanov, R. Syunyayev, Ye. Churazov, G. Babalyan, M. Pavlinskiy, N. Yamburenko and N. Khavenson, Space Research Institute, USSR Academy of Sciences, Moscow]

UDC 524.354

[Abstract] The ART-P coded-mask telescope, part of the "Granat" international astrophysical observatory, enables the construction of images of the sky in sectors of 1.8 x 1°.8 and the recovery of spectra of sources in the energy range 4-30 keV. The rather good time resolution (about 4 ms) makes the telescope a convenient tool for investigating X-ray pulsars. The article gives the first results of observations of well-known pulsars (Her X-1, SMC X-1, Cen X-3, OAO1657-415, 4U0115+63 and GX1+4) in February-August 1990. The periods of the pulsars were measured. The correctness of referencing to UT and the used time analysis procedures were checked by comparison of the values of the period obtained when observing the 33-ms pulsar in Crab nebula, with extrapolation of radio observation data. The accuracy in determining the period of pulsations was $< 10^{-7}$. (A separate article will be published devoted to discussion of the spectra of X-ray pulsars registered using the ART-P telescope.) Figures 6; references 11: 3 Russian, 8 Western.

## Two Hard X-Ray Sources Near Galactic Center: Known Source 1E1740.7-2942 and Newly Discovered Source GRS1758-258

*917Q0088C Moscow PISMA V ASTRONOMICHESKIY ZHURNAL in Russian Vol 17 No 2, Feb 91 pp 116-125*

[Article by R. Syunyayev, M. Gilfanov, Ye. Churazov, M. Pavlinskiy, G. Babalyan, I. Dekhanov, A. Kuznetsov, S. Grebenev, S. Yunin, N. Yamburenko, B. Cordier, F. Lebrun, P. Laurent, J. Ballet, P. Mandrou, J. P. Roques, G. Vedrenne and L. Boucher, Space Research Institute, USSR Academy of Sciences, Moscow; National Space Research Center, Toulouse, France; Astrophysical Service, Nuclear Research Center, Saclay, France; Cosmic Radiations Research Center, Toulouse, France]

UDC 524.354

[Abstract] The Granat astrophysical observatory for research in the X-radiation and soft-gamma radiation ranges, launched on 1 December 1989, carried two coded-mask telescopes (ART-P and SIGMA). This article reports its discovery of a new hard X-radiation source GX5-1. The spectrum recorded extends from 4 keV to 300 keV. In that energy range, the source luminosity was 2.2 x $10^{37}$ erg/s (assuming a distance to the source 8.5 kps). The source was pinpointed with an accuracy to one minute of arc. The spectrum of the source GRS1758-258 is close to the spectrum of 1E1740.7-2942, the only bright source of hard X-radiation, discovered by the SIGMA telescope in the neighborhood of the center of the Galaxy (luminosity in the range 4-300 keV is 3.2 x $10^{37}$ erg/s). The hardness of the spectra observed and the presence of an exponential cut-off of the spectrum at an energy of about 200 keV make it possible to regard both sources as black hole candidates. Figures 4; references 25: 4 Russian, 21 Western.

## Anomalously Hard Spectrum of Source 1E1740.7-294 Determined From Data From 'Rentgen' Observatory on 'Kvant' Module

*917Q0088D Moscow PISMA V ASTRONOMICHESKIY ZHURNAL in Russian Vol 17 No 2, Feb 91 pp 126-134*

[Article by R. Syunyayev, K. Borozdin, M. Gilfanov, V. Yefremov, A. Kaniovskiy, Ye. Churazov, G. K. Skinner,

O. Al-Emam, T. G. Patterson, A. P. Willmore, A. C. Brinkman, J. Heise, J. J. M. In't Zand, R. Jager, W. Voges, W. Pietsch, S. Doebereiner, J. Engelhauser, J. Truemper, C. Reppin, E. Kendziorra, B. Mony, M. Maisack and R. Staubert, Space Research Institute, USSR Academy of Sciences, Moscow]

UDC 524.354

[Abstract] Observations made with the Granat observatory in 1989 in the hard X-radiation range (E > 30 keV) revealed that the source 1E1740.7-294 predominates in the vicinity of the center of the Galaxy. This makes it possible to use observational data from the HEXE spectrometer of the Rentgen observatory in the Kvant module for determining the source spectrum. The observational data obtained with the TTM telescope and HEXE instrument are discussed, albeit separately because 1E1740.7-294 was in the HEXE field of view during only one of the seven observation sessions considered. The anomalously hard spectrum of the source makes it possible to regard it as a possible black hole (together with the sources Cyg X-1, GS2023+338, GS2000+25, AO620+00 and GRS1758-258). Figures 5; references 18: 1 Russian, 17 Western.

## First Results of Measurements of Charged Particle Fluxes on 'Granat' Spacecraft

*917Q0088E Moscow PISMA V ASTRONOMICHESKIY ZHURNAL in Russian Vol 17 No 2, Feb 91 pp 135-140*

[Article by Ye. A. Chuchkov, S. I. Yermakov, V. B. Kadobnov, N. N. Kontor, G. P. Lyubimov, T. I. Morozova, Yu. A. Rozental, T. I. Stepina, V. V. Tochilina, V. I. Tulupov and S. A. Filippychev, Nuclear Physics Scientific Research Institute, Moscow State University]

UDC 520.6

[Abstract] The KS-18-M instrument carried aboard the Granat spacecraft for measuring fluxes of charged particles is described. It consists of two modules—one of which is on the solar side, the other, on the antisolar side, thereby ensuring recoeding of particle fluxes from both the solar and antisolar directions. Each module consists of an identical set of detectors: two single silicon semiconductor detectors (SCD), two SCD telescopes, a gas-discharge counter with a small window, and two other gas-discharge counters. The data produced correspond to the number of particles recording in each recording channel during the period between interrogations (interrogations were made each 20 minutes). Data are given on variations in the intensity of protons for two typical energy intervals: 1.2-2 meV and > 20 MeV (these data were "cleansed" of the contribution of radiation associated with the Earth's radiation belts). Information is given, for example, on fluxes of solar protons of relatively low and high energies recorded in the vicinity of the Earth outside its magnetosphere, during the initial segment of Granat's flight during a period with 28 solar proton events with low-energy protons. Sixteen of those events were accompanied by increases in the flux of high-energy protons. Particular attention is given to an unusual solar proton intensity increase recorded on 19 March 1990. It is emphasized that the data presented are only the first, fragmentary results of such measurements. Subsequent publications on this subject will appear as data processing continues. Figures 3; references 6: 2 Russian, 4 Western.

## Measurement of Simeiz-Pushchino Interferometer Baseline Parameters

*917Q0088F Moscow PISMA V ASTRONOMICHESKIY ZHURNAL in Russian Vol 17 No 2, Feb 91 pp 185-189*

[Article by M. V. Golovnya, D. A. Graham, L. I. Matveyenko and A. V. Shevchenko, Main Astronomical Observatory, Ukrainian Academy of Sciences, Kiev; Max Planck Radio Astronomy Institute, Bonn, FRG; Space Research Institute, USSR Academy of Sciences, Moscow]

UDC 520.274;524.7

[Abstract] The Simeiz-Pushchino radiointerferometer is now used at a wavelength 18 cm for research on astrophysical objects, including observations in the global network of radiointerferometers. The interferometer consists of two 22-meter parabolic antennas outfitted with coherent heterodynes and time keeping units based on hydrogen frequency standards. The low-noise transistor-type amplifiers, cooled to the temperature of liquid nitrogen, have a noise temperature about 30 K. The noise temperature of the system is 55-60 K. Mark-2 systems ensure the recording of the signals received in two channels, each with a 20-MHz bandwidth. The two-channel recording system makes it possible to receive signals in two polarizations or at two different frequencies in the event of wide-band synthesis. The effective area of the antennas, with multimode feeds, is 210 $m^2$. The parameters of the interferometer baseline were measured with observational data recorded in November 1989. The geodetic measurements were made from quasars whose coordinates were known with a high accuracy. The geocentric coordinates of the Simeiz and Pushchino instruments and lengths of their baselines are tabulated. The total errors in measuring the baseline parameters are 2 m in the X, Y coordinates and 5 m in the Z coordinate. The sources of these errors and ways in which they are compensated are discussed. References 4; 2 Russian, 2 Western.

## Radio Probing of Earth's Atmosphere With Two Satellites

*917Q0092 Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 315, Nov-Dec 90 pp 101-103*

[Article by O. I. Yakovlev, V. A. Grishmanovskiy, S. D. Yeliseyev, A. I. Kuperyavenkov and S. S. Matyugov,

Radio Engineering and Electronics Institute, USSR Academy of Sciences, Fryazino, Moscow Oblast]

UDC 621.396.96

[Abstract] The lack of experimental data on the radiophysical effects produced by the Earth's atmosphere during radio probing prompted the researchers here to perform a study in which an orbital vehicle emitted radio waves in the decimeter range to a geostationary satellite that received the signal and relayed it to the ground. Since radio waves in the decimeter range are not absorbed by the atmosphere, the variation in field strength noted in these experiments was caused by refraction. Varying the frequency during probing makes it possible to obtain the dependence of the refraction angle in the atmosphere on altitude. The attenuation of radio waves by refraction yields information on the position of the tropopause and stratified formations in the atmosphere. Amplitude data yield information on the state of the atmosphere to an altitude 25 km. A frequency change caused by the influence of the atmosphere makes it possible to determine the dependence of the angle of refraction of radio waves on the minimal altitude of the beam line for altitudes up to 40 km. Using these data it is possible to make a reliable determination of the altitudinal profile of the reduced refractive index. The presented data demonstrate the effectiveness of radio probing as a method for monitoring the Earth's atmosphere. Figures 4; references 4: 3 Russian, 1 Western.

## Determining the Relative Orientation of Coordinate Systems in the Optical and Radio Ranges From Nonsynchronous Observations of High-Orbit Satellites

*917Q009 Kiev KINEMATIKA I FIZIKA NEBESNYKH TEL in Russian Vol 7 No 1, Jan-Feb 91 pp 3-12*

[Article by D. P. Duma and Yu. N. Ivashchenko, Main Astronomical Observatory, UkSSR Academy of Sciences, Kiev]

UDC 521.96 (085)

[Abstract] One of the two techniques used for determining the relative orientation of coordinate systems is associated with random and systematic errors that result from the use of a stepped photographic method of observation and from inability to match emission centers in the optical and radio ranges. In addition, there are only 30 or so radio stars that are radio sources brighter than $12^m$ with radio emissions of no less than 0.01 jy, and most of them are variable and have multiple components. The other technique used is the focus of this study. It usually requires ground facilities that include at least three radiotelescopes, a laser range finder, and an optical telescope for determining relative satellite and star position. Synchronous observations, as a rule, are necessary. In the work reported here, the researchers examine two versions of that technique, neither of which requires synchronous observations. One involves determination of the elements of the relative orientation of the coordinate systems from combinations of satellite orbital elements; the other, determination from the differences of normal points plotted from radiointerferometry and optical observations. It is shown that the orientation angles can be found with an accuracy equivalent to that of the plotting of fundamental star catalogues. The first technique is used for observations of high-orbit satellites made from various ground points; the second, for observations from one point. Figures 1, references 18: 13 Russian, 5 Western.

## Influence of Noncentricity of the Moon's Gravitational Field on the Motion of Geodynamic Satellites

*917Q0100 Kiev KINEMATIKA I FIZIKA NEBESNYKH TEL in Russian Vol 7 No 2, Mar-Apr 91 pp 67-77*

[Article by A. N. Marchenko]

UDC 629.783+528.21

[Abstract] Improvements in the accuracy of laser observations of satellites and the advent of high-orbit geodynamic satellites have led to the need for studying previously unstudied factors that have a minute influence on satellite motion. One such factor is the influence of the noncentricity of the Moon's gravitational field. Traditionally, celestial mechanics and space geodesy have viewed the pull of the Moon's gravity from the standpoint of centricity only, obtaining the sought-for perturbing function by solving a three-body boundary problem. For the noncentricity of the Earth's and the Moon's fields, whose gravity potentials are described by finite series of spherical harmonics, a direct solution of the problem can be effected by means of direct representation of force components in the form of series with harmonic coefficients of selenopotential and geopotential. Here, however, the researchers choose a different approach, one based on the introduction of a momentary planetary center of gravity. A numerical algorithm is constructed for computing the effect of noncentricity, and it is tested in the calculation of orbits for geodynamic satellites such as LAGEOS and Etalon. The researchers caution that in the context of the model they use for satellite motion, the Moon exerts a three-way influence: the direct attraction of the satellite by the Moon; an indirect influence consisting of the attraction of the Earth by the Moon; and effects associated with Earth tides. Figures 1, references 10: 6 Russian, 4 Western.

## Andrey Sakharov's Views on SETI

*917Q0066A Moscow ZEMLYA I VSELENNAYA in Russian No 6, Nov-Dec 90 pp 63-67*

[Article by L. M. Gindilis, candidate of physical and mathematical sciences, under the rubric "Hypotheses,

Discussions, and Suggestions": "Andrey Dmitriyevich Sakharov on the Search for Extraterrestrial Civilizations"]

[Text] Few people are aware of the fact that, in the multifaceted scientific and public life of Andrey Dmitriyevich Sakharov, there was an episode related to the search for extraterrestrial intelligence, and as a result of that, he left us his thoughts on that subject.

In 1971, in preparation for the Soviet-American Conference on Communication with Extraterrestrial Intelligence (CETI) [ZEMLYA I VSELENNAYA, No 2, p 49; No 3, p 48], the organizing committee prepared a questionnaire and disseminated it to those who were expected to participate in the conference, as well as to a number of scientists whose opinions on the subject were of interest. A total of 64 questionnaires were sent out, and answers were received from 37 individuals, including a letter from Andrey Dmitriyevich Sakharov.

Excerpts from the answers to the questionnaire items were published in the journal ZEMLYA I VSELENNAYA in 1972 (No 4, p 57—*Ed.*). Greater detail was expected to be included in the appendix to the Russian edition of the conference transactions ["Problema CETI (Svyaz s vnezemnymi tsivilizatsiyami)." Moscow, Mir, 1975]. S. A. Kaplan and I prepared a long article that was accepted by the publishing house. However, when the collection of articles was about to be published, the civil-rights activity of Andrey Dmitriyevich Sakharov had reached such an amplitude that the mention of his name in publications was considered undesirable. It was suggested that we remove those portions of the text relating to him, and we refused, and the article was not published. And all these years, I have kept that letter from Andrey Dmitriyevich Sakharov.

The questionnaire consisted of 10 questions. Andrey Dmitriyevich answered four of them. Here are the questions.

6. *What expenditures of money and time do you consider acceptable for setting up operations involving the detection of signals from extraterrestrial civilizations?*

7. *What is your opinion of the need for international cooperation in the search for extraterrestrial intelligence: Should there be (a) joint projects, or (b) coordination of CETI operations?*

9. *In what directions should CETI research be taken? What specific projects for the detection of extraterrestrial intelligence can you propose?*

10. *What is your opinion concerning the possible consequences of contact?"*

Below is the full text of the letter from Andrey Dmitriyevich.

*In response to the CETI questionnaire, from A. D. Sakharov.*

*Dear L. M. Gindilis!*

*Below, I give you my opinion on only three items in the questionnaire—10, 6, 9, 7 [This is how the text of the letter appeared. Andrey Dmitriyevich had probably intended to answer three questions, but later added a fourth.—Ed.] and I ask that you forgive my lack of expertise with respect to those items as well as to the others, which, for that reason, I left unanswered.*

*10. Is there any danger associated with receiving information from an extraterrestrial civilization? Premature knowledge whose essence remains uninterpreted could, theoretically, be dangerous. But as it applies to such a mature organism as terrestrial civilization, if the information is gradually perceived and received, those dangers do not seem real to me. The creation of an artificial "superbrain" is far more dangerous because of the presence of feedback, but there, too, it seems to me that the dangers of "dehumanization," information poisoning, etc., are greatly exaggerated. The broadening of our views upon the receipt of information from a nonhuman intelligence will be an important, but auxilliary and, in my opinion,* ***very positive factor in the development of our scientific knowledge, in the conquest of our naive anthropomorphism, and in the development of our ethical and social institutions.*** *But, as before, the determining factor will be the internal forces of human society—accumulated knowledge and skills, traditions and institutions, the genetic pool of mankind, material productive forces, and the state of the Earth's environment. It is something of a generalization, but it can be said that for the intelligent and the good, any additional knowledge is only a plus, but for the stupid and the malicious, who are doomed to self-destruction, no one can be of any help or any harm. Being an optimist, I am in favor of a persistent search for the "call letters" of extraterrestrial intelligence.*

*6. In light of the importance of the problem and, at the same time, in light of the possibility that, scientifically and technically, we may not be quite mature enough to solve it, I consider the following solution of the financial problem to be advisable. In the next five-10 years, gradually bring the spending on special CETI research up to 5 percent of the total spending on astronomy and astrophysics, which would include the spending for astrophysical and astronomical research in space. At the same time, programs of "combined" research whose basic objective is unrelated to CETI should be discussed and adopted, but the processing and observation system would take into account the interests of CETI.*

*That's just a rough estimate, especially since I don't know what 100 percent is for the USSR, the United States, or the world as a whole.*

*7. International cooperation in executing projects is desirable. It is also desirable to raise the issue of drawing up and adopting an international agreement requiring the immediate (say, within a week or a month) publication of anything suspected to be the signal of an extraterrestrial intelligence, before it is analyzed in detail by any country.*

*9. The scientific-technical aspect of the matter. We cannot completely discount the notion that we still know too little and are able to do too little. We cannot preclude the possibility that there are gaping holes in our fundamental concepts of space—for example, concerning its topological structure—and that extraterrestrial civilizations are taking that circumstance into account when they send their transmissions, but we are merely "looking in the wrong direction." Nor can we preclude the possibility that there are glaring gaps in our knowledge of the types of radiation existing in nature. It is even more probable that our correspondents, in using types of radiation and natural laws already known to us, may be relying on a sensitivity level of receivers that is still entirely inaccessible to us for technical, production, and economic reasons. However, none of those doubts should dissuade us from a path of attempting to detect signals that would include a gradual increase in the sensitivity (and cost) of receiving equipment and an expansion of the search methodology. Only in that way can we count on achieving success sooner or later. I would like to note the importance of working signal-sending project operations into specific projects; only in that way will it be possible to understand the fine aspects of contacts. Here, as in other matters, the egotists, in the long run, will be the losers.*

*9a. I want to discuss briefly one specific variation of a communication system. In order to avoid the blinding effect of the sun, once every 10-20 years several one-time signal sources ("flashbulbs," or FB's) should be sent out the solar system. The flashbulbs would be sent out in a single straight line and would be positioned at equal distances from one another (Fig. 1) [not reproduced]; then they would be exploded synchronously (in a system of coordinates referenced to the sun) or at equal time intervals (a criterion of artificiality!). The energy source for each FB would be a powerful thermonuclear blast.*

*The energy of the blast would be easily transformed into a short flash in the light range, radio range, etc. The size of the FB system would, of course, have to be rather imposing (spanning kilometers), but the weight need not be very great. For example, by using the energy of the detonation products to compress a thin layer of gas (argon), it is easy to produce a very short flash in visible light, with any microstructure for the transmission of information (Fig. 2) [not reproduced].*

*The receiver would consist of an optical telescope that records signals in time and has good angular resolution.*

*Respectfully and with best wishes for the conference,*

*A. Sakharov*
*8 August 1971*

Almost two decades have passed since those lines were written. For our changing times, that is a fairly long period. We will attempt to look at the answers of A. D. Sakharov from a present-day standpoint.

It seems noteworthy to me that Andrey Dmitriyevich began with the last question—concerning the possible consequences of contact. As a citizen of the world, he was interested first and foremost in that question. It should be noted that in recent years that problem has attracted more and more attention from the scientific community. It has been the subject of special discussion at several CETI sessions organized by the International Astronautics Academy and the International Space Law Institute. A draft of an international agreement has been prepared that would regulate the actions of individuals and organizations in the event that a signal from an extraterrestrial intelligence were detected. The matter of possible publication in that case has been discussed in detail. The specific nature of a positive result in the search for extraterrestrial intelligence is that such a result would affect not only the interests of a narrow group of scientists, but also the interests of all of mankind; it could exert a serious influence on the development of our terrestrial civilization. Space law specialists have concluded that, in any case, there must be broad publication of any report of the reception of a signal from an extraterrestrial intelligence. Thus, the ideas of Andrey Dmitriyevich Sakharov, although they have remained virtually unknown to the scientific community, are gradually finding their embodiment and further development.

I would like to turn our attention to the idea of Andrey Dmitriyevich on the gradualness of influx and perception of information. The reception of information from an extraterrestrial intelligence is often regarded as something that would be a single event of detection and interpretation of signals. Such sudden detection could lead to acute social consequences—and the more serious they were, the less prepared we would be for them. However, such a model of contact is not at all necessary. Rather than a single event, the contact could be a lengthy process covering several generations. In that case, the social impact of the contact would be lessened over time.

A. D. Sakharov felt that the principal result of contact with an extraterrestrial intelligence would be that it would broaden our views, help us overcome our anthropomorphism, and improve our ethical and social attitudes. It is interesting to note that these thoughts of Andrey Dmitriyevich run the same course as the ideological concepts of Russian cosmism and Living Ethics [Zhivaya etika] in their clear realization that, all things considered, the fate of mankind is, in the final analysis, determined by the internal state of mankind.

The comment of A. D. Sakharov about "combined" research is important. At present, some 50 experiments are being carried out around the world in the search for signals from extraterrestrial intelligence. As we know, they have not yet been crowned with success. That is entirely explainable and even inevitable. It would be naive (not to mention, wrong) to count on rapid and easy success in solving such a grandiose problem. But getting only negative results over a lengthy period of time creates an extremely unfavorable psychological atmosphere. To surmount that, the research should be set up in such a way that it deals with specific astrophysical problems as well as with the search for extraterrestrial

intelligence. Then, even in the absence of signals, the experimental results would not be negative. Many scientists are now taking that circumstance into account and are striving to set up their research in precisely such a way. The special term "accompanying search" has even appeared. Although Andrey Dmitriyevich himself was never involved in the search for extraterrestrial intelligence, he looked into that difficulty very thoroughly and indicated the proper direction for the development of research.

Discussions of the CETI problem have repeatedly pointed to to the possibility of the existence of communication channels that are based on natural laws unknown to us and on unknown signal carriers. Certain individuals have expressed doubts concerning the legitimacy and advisability of searching for signals in the radio range (or in other ranges of electromagnetic waves). A. D. Sakharov also notes the limited extent of our knowledge and the possibility of the existence of other signal carriers, but he emphasizes that that should not dampen our interest or serve as a reason for ending CETI experiments.

Initially, when the approaches to the CETI problem were being formulated, we relied primarily on the detection (or reception) of signals. That is still true to this day. A. D. Sakharov pointed out the need to combine that search with the sending out of signals. The first steps in that direction were taken later. In 1974, a message to extraterrestrial civilizations was sent from Arecibo Radio Observatory (in the direction of the spherical cluster M-13). One might also mention the message records on the Pioneer 10 (1972) and Voyager 1 and Voyager 2 (1977) space vehicles [ZEMLYA I VSELENNAYA, 1982, No 4, p 54—*Ed.*). It goes without saying that those attempts cannot be regarded as serious efforts to actively establish contact with extraterrestrial intelligence. But it is just such experiments that, as mentioned by A. D. Sakharov, we can't do without if we are to understand the "fine aspects of the problem of contacts." It is no accident that one of the authors of the message on Voyager, John Lomberg, wrote that "even if the messages are never found, they will serve as a good lesson for us in writing and divining messages from space if SETI (Search for Extraterrestrial Intelligence) is ever crowned with success."

The method proposed by A. D. Sakharov for signaling in the optical range with thermonuclear "flashbulbs" is probably of interest to specialists. With today's telescopes, such a flash could be detected from as far away as the nearest stars. To detect very short light pulses, one could use systems like the MANIYa instrument complex, which was developed at the Special Astrophysical Observatory, USSR Academy of Sciences, under the direction of V. F. Shvartsman, precisely for searching out signals from extraterrestrial intelligence in the optical range. Andrey Dmitriyevich proposed that on a systematic basis, once every 10-20 years, we send several thermonuclear projectiles outside the solar system and detonate them there. It goes without saying that if that project were ever carried out, there would have to be an appropriate international agreement ensuring safety when the projectiles were put into orbit. If safety conditions were adhered to, that wouldn't be a bad way of ridding the Earth of nuclear weapons. Is not the project proposed by A. D. Sakharov an example of an "accompanying" experiment in which we could solve two interrelated problems—nuclear disarmament on the Earth and communication with extraterrestrial civilizations?



## Satellite Launch Failure Reported

*PM1207104991 Moscow KRASNAYA ZVEZDA in Russian 10 Jul 91 First Edition p 5*

[Unattributed report: "Failed Launch: From the Press Service of the Chief of Space Units"]

[Text] A Cosmos artificial earth satellite (code number 2152) was launched at 1620 hours on 25 June. The satellite, launched from the northern space station of Plesetsk, was due to enter its planned orbit by firing the first-stage engine and firing the second-stage engine twice. This process was monitored for nine minutes from the space station and then for around 11 minutes by units of the control and measuring complex [komandno-izmeritelnyy kompleks] after which the rocket left the zone of visibility.

The first stage separated in the planned area after using its fuel and the second-stage engine fired. Approximately 30 minutes after take-off the second, brief firing of the second-stage engine was due to take place but this did not happen, according to the specialists, because of malfunctions in the engine's pneumatic control system. Consequently the second stage, which was attached to the satellite, left its planned orbit and, descending in a ballistic trajectory, passed over Antarctica and burned up in the dense layers of the atmosphere over the Atlantic in a shipping-free region northeast of the South Canaries.

## 'Zenit' Launch Attempt Postponed, Australian Delegation at Cosmodrome

*PM0208104491 Moscow KRASNAYA ZVEZDA in Russian 30 Jul 91 First Edition p 4*

["Reportage From the Cosmodrome" by KRASNAYA ZVEZDA correspondent Lieutenant Colonel A. Vorobyev: "Zenit": Postponed Launch"]

[Text] Saturday 27 July, 1991. The Baykonur Cosmodrome. The "Zenit" booster rocket stands on the launch pad in readiness for the launch. Its payload is to be a military-technical satellite. The purpose of inserting it into orbit is for verification of the fulfillment of treaty commitments on disarmament problems. Representatives of the Australian Space Organization, headed by Doctor Bruce S. Middleton, are present for the launch, along with your correspondent.

"Zenit" is shaped like a pencil. Except it is 57 meters tall!

Dr. Bruce Middleton asks knowledgeable questions, after all, he is managing director of the Australian Space Organization. With him are experts from the United States and Australia. The shutters of their cameras are clicking. Sometimes Colonel Yu. Zorin, chief of the center for testing and launching space devices, makes a warning gesture. The experts understand and nod: For them, until a contract has been signed, this is a commercial and technical secret. At this time there are no service personnel on the launch pad. The launch will be soon. To the experts' surprise, all the work is fully automated, according to a well-rehearsed "unmanned launch" procedure.

The Australian representatives still have time to walk around the launch installation and inspect the installations at the space rocket complex. For myself, I hurry to the launch control center, which is in an underground building not far from the launch pad. I descend through the stories—first, second, third. It is hot on the surface, but down here it is cool. The huge metal doors of the bunker, with wheel-operated locking systems, are impressive. And here is the room where the control panel is located. On the monitor screens you see the "Zenit," ready for launch.

From here commands are issued over the loudspeakers by the "gunner"—Lieutenant Colonel D. Chistyakov, commander of the engineering-testing unit. His deputy is Major A. Svetlichnyy.

I see the excitement in Colonel General of Aviation German Stepanovich Titov, "cosmonaut number two." He is now first deputy chief of the Defense Ministry Space Units. The previous evening I talked with him on the banks of the Syr-Darya, at the very spot where, in 1961, the State Commission sat prior to Gagarin's flight. German Stepanovich says:

"For me, 'Zenit' means many years of my life, my favorite child. Its engine is truly unique—ecologically, the cleanest that exists in the world. I know a number of foreign firms are showing interest in it. After all, the booster rockets that exist today were for the most part designed several decades ago. "Zenit" has excellent specifications: With a launch weight of 439 tonnes, it can insert 15 tonnes of payload into orbit. I remember how V. Utkin, who at the time was general designer and general director of the "Yuzhnoye" Science and Production Association, called me and unofficially invited me to become chairman of the state commission for the "Zenit" program. I realized the work would take many years. But do you know what it meant to become chairman of this commission?! It was necessary to take "Zenit" all the way from bench tests where the engine blew up literally after 30 seconds, to full readiness for use in space. I led 14 first launches. And they were all successful. When I was on leave I learned about the disastrous 15th launch. Nonetheless I am convinced that "Zenit" will prove itself."

Specialists from the Defense Ministry Space Units cited a number of interesting figures about 'Zenit.' For instance, it is the first booster rocket to be launched by an automated system. The time to takeoff from No. 1 readiness is 10 times shorter than for the "Proton." A launch of the analogous American "Titan," according to experts' assessments, costs around $35 million, while "Zenit" costs several times less. True, "Titan" can take 17 tonnes into orbit, while our booster can as yet carry only 15 tonnes (but that is not the limit, it is improving).

A launch of the French "Ariane" costs 35 million francs, so here too the comparison is in favor of our booster rocket. And "Ariane's" payload is less than "Zenit's."

...From the observation post viewing platform to the launch site is several kilometers. This is a safety requirement. A group of foreigners with binoculars waits for the launch. I already know nearly all of them—Robert Goss, Brogan Edward Layton, Egan John (who is rather like James Bond, the darling of the thriller fans), and also Ulibarri Entoni [name as transliterated]. The automatic withdrawal of the transport installation unit proceeds smoothly. The rocket stands awaiting its flight. A minute to go, 30 seconds. And suddenly the hissing over the loudspeaker falls silent. Something has happened there, on the launch pad. Involuntarily I check the time—seven seconds to launch. Will the automated system work now, will it have time to halt all the systems, or, on the contrary, will it release the rocket from its "embrace"? And then an order comes over the speakers—launch postponed. Seven seconds away! I see the Australians discussing the situation.

Now it is necessary to find out the reason for the hitch. Everyone is calm. This has happened often, not only to us. Universally, if there is even the slightest doubt, experts prefer to postpone the launch. Dr. Bruce Middleton, managing director of the Australian Space Organization, after a concrete assessment of the situation, confirmed in a conversation with cosmodrome experts that the postponed launch will in no way affect the

conviction felt by him and the experts, who have previously visited virtually every cosmodrome in the world, that "Zenit" is reliable.

"We value highly the openness and frankness we have encountered here," Middleton told your correspondent. "We saw them assembling "Zenit" in Dnepropetrovsk, and now at Baykonur we have seen them preparing it for launch. This openness is very important for the future use of Soviet space technology for commercial purposes."

He also shared the Australian Space Organization's plans for creating an international cosmodrome in Australia.

And so the "Zenit" booster rocket is once again preparing for launch.

## Zenit Booster Launch Failures Discussed

*917Q0164A Moscow KRASNAYA ZVEZDA in Russian 31 Aug 91 p 2*

[Interview with F. Chelkis and I. Pisarev, experts from the Energomash Scientific-Production Association and Yuzhnoye Scientific-Production Association, by M. Fedorov; place and date not given: "What Happened With the Zenit?]

[Text] **A Zenit rocket—one of the boosters for which a great deal of work is planned in implementing the space programs—was to have been launched on 27 July. The launch was postponed for technical reasons. When it reported this, KRASNAYA ZVEZDA promised its readers that it would inform them about these "technical reasons." Today we publish the answers given by leading experts from the Energomash Scientific-Production Association and Yuzhnoye Scientific-Production Association, design engineer F. Chelkis and I. Pisarev, to these questions.**

[Fedorov] Can you say a few words about the rocket and its characteristics?

[Pisarev] It is a quite powerful booster that is launched completely automatically or, as we say, unmanned. The booster makes use of the latest technology and is capable of carrying out various missions in space research, not only today but in the long term. It is based on the first-stage RD-170 four-chamber engine and the Energiya rocket system. I would call it unique.

[Fedorov] How is it unique? Both here and abroad the building of boosters has become such a developed sector and has gained so much solid design experience that, well, to talk about uniqueness...

[Chelkis] Let me try to dispel your doubts with facts. The basic features of the RD-170 characterizing its power and inexpensiveness are these: sea-level thrust of 740 tons and specific impulse in vacuum, 337 units. These are the highest achievements reached in world engine building for this class of engine. These very high energy parameters are ensured by the scheme used in the RD-170. The mass carrier for the engine turbine is the products from the combustion of kerosene and oxygen at a temperature of about 700 degrees Kelvin, with a 95-percent proportion of oxygen. After passing through the turbine the working medium is directed into a combustion chamber where it is mixed with the main part of the kerosene. Up to now no company abroad has experience with engines that operate in this way.

[Fedorov] You are talking about design features, but there is also the criterion of reliability.

[Chelkis] Undoubtedly. During the course of development of the engine, in addition to the numerous tests of its subsystems and units, about 900 test firings of the entire engine were carried out. Good results were obtained. Suffice it to say that during the static tests the efficiency of the engine was confirmed during the process of 17 full flight-time burns and 25 burns.

[Pisarev] Let me add that at this time there have been 15 firings of the Zenit booster and two firings of the entire Energiya system, as the results of which the engine's high level of reliability has been confirmed.

[Fedorov] It was reported in our newspaper that on 4 October 1990 there was an accident with a Zenit booster. The first stage of the engine spontaneously switched itself off five seconds after ignition and resulted in the booster falling back onto the launch pad, with a subsequent explosion.

[Pisarev] This was totally unexpected for us. Today we can state quite definitely what the reason was. As a result of analysis of the telemetry data and the material parts that remained it has been established that there was nothing unusual about the prelaunch preparations or the initial part of the flight, and that the initial site giving rise to the development of the accident was the oxygen cooling channel assembly in one of the four chambers.

[Chelkis] Let me explain how the study was conducted. Four main groups of scenarios were selected: incorrect assembly of the engine, defects leading to a reduced safety margin, broken seals in the oxygen channel, and ingress of foreign bodies or substances into the internal chamber. It was with respect to the last named that we were able to reproduce the process whereby the accident occurred. It was established that the cause was the ingress of an oily-type organic substance into the oxygen chamber of the engine. This could have happened only as the result of some random violation of the technological process in the work after the static firing test.

[Fedorov] But what happened in July of this year?

[Pisarev] A booster rocket is a very complex technical system. It is difficult to calculate all the assemblies and parts of the structure that could affect the precise operation of the entire system. During the course of preparation for the launch and the launch, numerous parameters are monitored automatically. When an automatic device detects a malfunction it stops the launch process.

[Chelkis] The reason for the malfunction has been established. It was not a design error or the sudden detection of unknown defects but a violation of the technological process, or, more accurately, a mistake by people.

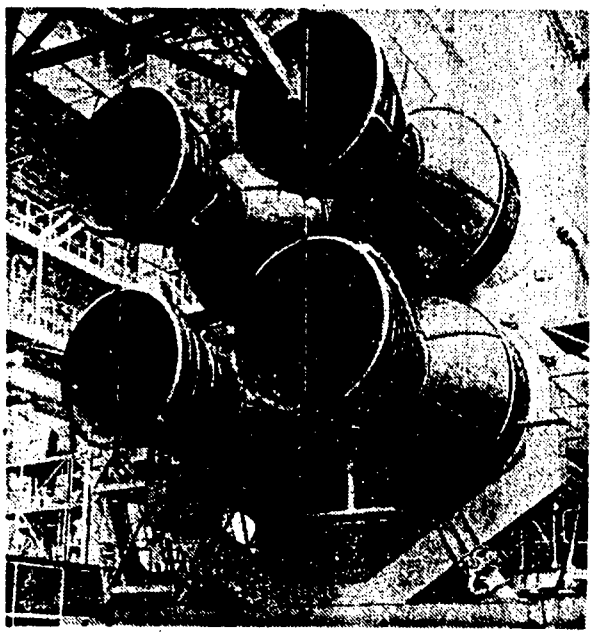
The studies that have been conducted also showed that the engine is reliable and that there is a considerable safety factor, and also that the structural elements are resistant to various defects introduced artificially in particular elements. Moreover, experience gained in developing the RD-170 will become the basis for the development of promising new engines of various sizes, while the Zenit will compete successfully in the world "space market."

## Energiya Booster Facility at Baykonur Cosmodrome

*917Q0158 Moscow PRAVDA in Russian 25 Jul 91 p 1*

[Unsigned: "Energy for the 'Energiya'"]

[Text] Plant personnel involved in the creation of space equipment, in particular, elements of the Energiya booster, work in the assembly-test complex of the Samara Plant "Progress" located at the Baykonur Cosmodrome. Each launch is a significant event which requires outlays of time, energy, cooperation, and precision. Today the Energiya is being prepared for a future launch with the Buran.



**In the assembly-test complex of the plant**

**Chiefs of the testing and main assembly shop: V. Kalashnikov (left), S. Pankratov, and A. Yelkin**

## Early Spaceplane Project of Myasishchev Design Bureau

*917Q0076 Moscow SOVETSKAYA ROSSIYA in Russian 10 Apr 91 First Edition p 4*

[Article by V. Petrakov and M. Chernyshov, under the rubric "Without the Stamp 'Secret'": "The Unknown Buran"; first five paragraphs are source introduction]

[Text] **Lately, a great deal of what is almost investigative reporting devoted to the history of the development of reusable spacecraft—the Soviet Buran and the American Shuttle—has been published on the pages of foreign aerospace magazines. The writers have presented drawings of Soviet winged rockets and space planes similar to the reusable craft. What is this? Buran? Or its predecessor, which appeared before the Shuttle?**

**Scientists use the expression "working in a fluidized bed." That refers to a situation in which one and the same idea possesses their minds, regardless of the scientists' citizenships. Hypothesizing, but not knowing, about the specific results of each other's work, the groups of researchers engage in an intense quest. Who will reach the goal first? We sometimes don't learn about it until decades later.**

**Many people probably remember the picture of the first appearance of the Buran craft at Baykonur. The snow-white, iron-shaped aircraft was resting on the back of a giant bomber aircraft. That is precisely how Buran was brought from the plant to the steppes of Kazakhstan. The occasion was quite symbolic, a unique illustration from the history of Soviet rocket-space technology.**

**Recently declassified documents indicate that, back in 1957, a reusable aerospace plane was being developed in the USSR. The project's developer was the famous aircraft designer, Vladimir Mikhaylovich Myasishchev.**

**Strategic bombers of his design are still part of the country's defense system. It was one of those very craft that was refitted to transport Buran.**

Vladimir Mikhaylovich Myasishchev was born in the city of Yefremov, in Tula Oblast, in 1902. He graduated from the Moscow Higher Technical School imeni N. E. Bauman. For many years, he worked in the design bureaus of A. N. Tupolev and V. M. Petlyakov. He specialized in the design of heavy aircraft.

Several outstanding craft are known to have been developed under Myasishchev's supervision: the high-altitude M-2 bomber and several strategic bombers, including the supersonic, missile-armed M-50. That is in the encyclopedia. Also mentioned is the fact that the designer was awarded three Orders of Lenin. But here in front of us is a photograph of Vladimir Mikhaylovich [photo not reproduced], and quite visible in it is the gold star of a Hero of Socialist Labor. There is, however, not a word about that in the biographical information. That's strange, because at the time the photo was taken, those stars were given out merely for an "anniversary."

Foreign publications frequently print pictures of Myasishchev's powerful and strikingly beautiful vehicles. It's as if they know considerably more abroad about the designer than we do in our country. But only the aviation part of his biography is referred to in the foreign sources.

While developing the latest aviation hardware, Myasishchev also began work involving rocket research. As far back as the early 1950s, a group of scientists headed up by Academician M. V. Keldysh substantiated the feasibility of developing a supersonic pilotless aircraft. The craft was notable for its long range of flight and its large load-carrying capacity. In essence, what was being discussed was a two-stage rocket-plane system that would use atomic warheads to destroy targets.

The work on this system was entrusted to two aviation design bureaus—that of V. M. Myasishchev and that of S. A. Lavochkin—and a creative contest was organized between the two collectives. In OKB-23 [Special Design Bureau-23], headed by Myasishchev, the design work was conducted on a system labelled with the number "40." It was begun in April of 1953. The craft which was being developed by S.A. Lavochkin was called Burya [Storm]. In both special design bureaus, the problem was solved with what were, by and large, similar structural designs. The first stages were booster rockets, and the second stages were winged craft equipped with air-breathing jet engines.

The System-40 rocket-plane was supposed to lift off from the vertical position.

The aircraft had a flight range of 2,300 kilometers, and it developed a speed of up to 3,200 kilometers per hour. As has already been stated, the craft had been designed as a pilotless craft, but, at a certain stage in the testing, Myasishchev intended to install a cockpit for a pilot on it. The pilot would be able to eject and would descend by parachute. In developing that version, Vladimir Mikhaylovich probably wanted to ascertain what special features were involved in piloting hypersonic airplanes and to evaluate the psychophysiological capabilities of a person during such flights.

In 1957, the life of the M-50 Myasishchev long-range bomber was just getting under way, and Vladimir Mikhaylovich was already busy with another idea—a supersonic passenger plane. Myasishchev always had a lot of respect for science. Special aerodynamic tests had been conducted on the new area of research at TsAGI [Central Aerohydrodynamics Institute], and the basic requirements for the future craft were determined. The plane was planned in two versions: a passenger version and a so-called cargo-handling version. The first craft, designed for 100-120 passengers, was to develop a speed of up to 2,300 kilometers per hour. The second, with a seating capacity of up to 50 people, would be able to accelerate up to a speed of 6,500 kilometers per hour. Dreams? Utopia? Well, Myasishchev's supersonic bomber was already in the air.

Vladimir Mikhaylovich, however, was not allowed to finish the civilian aircraft project. It was taken away from him and transferred to A. N. Tupolev's design bureau. And there they went "their own way," organizing a race with the Concorde. And the time for the development of a Soviet supersonic plane slipped away, and Tupolev's design bureau, in the end, lost the competition to the Concorde. In any event, the TU-144 did not go into service.

In that same year of 1957, "40" and Burya were ready for flight tests. The first to undergo a check was Burya. But the tests ended in failure. That also had a telling effect on the operations schedule of project "40." Its launches were postponed, and, in November of 1957, the research was closed down altogether. The fact is that Korolev's intercontinental ballistic missiles had undergone successful launches.

The "higher-ups" figured that the rocket-plane systems were no longer needed. V. M. Myasishchev tried to fight for his creation. In 1958, N. S. Khrushchev and then-Minister of Defense R. Ya. Malinovskiy visited OKB-23. The guests became acquainted with Myasishchev's new M-50 strategic bomber. The designer attempted to raise the issue of the rocket-plane systems, but was unsuccessful. Aircraft, it seems, were no longer of any interest to N. S. Khrushchev. In time, an "arbitrary" decision would be made both to stop the work on the M-50 and to close certain aviation design bureaus. But that would come later, and, for the time being, Myasishchev continued to work on the M-50 and M-56 airplanes and on aerospace vehicles.

In the design bureau, new ideas were constantly being hatched not only with respect to craft designs, but also with respect to materials. For example, in late 1959, one of the associates of Ye. S. Kalug's design bureau, who was later a doctor of technical sciences, sent a memorandum addressed to V. M. Myasishchev with a proposal for the development of an aircraft on which so-called anisotropic fiberglass material, or SVAM, would be used. An aircraft with an interior lining of this material would become "invisible" to radio-frequency emissions. Radars would not be able to get a fix on it.

The general designer reacted immediately to the proposal. He instructed his own associates to present proposals for converting the long-range reconnaissance aircraft being developed by P. V. Tsybin to SVAM technology. Alas, they didn't have time to complete that work in OKB-23, either. But of course, the invisible Stealth aircraft that were recently developed in the United States were designed along the same principle as the SVAM technology.

The biggest event of 1957 was, of course, the launching in the USSR of the first artificial Earth satellite. The epochal event for Myasishchev turned out to be, as has already been mentioned, the closing down of the work on project "40." But that had no effect on the relationship between V. M. Myasishchev and S. P. Korolev. They had met one another during a difficult time and were even in the same Tsagovskaya prison (that fact from the biography of the prominent designers has been adequately illuminated in the press), and they were on good terms their entire lives. The country's chief rocket scientist—S. P. Korolev—even at the height of his own fame, invariably spoke warmly of Myasishchev.

Right after the launch of the first Soviet satellite, both S. P. Korolev and B. M. Myasishchev, almost simultaneously, set about designing vehicles for manned flights into space. Korolev settled on a version of a space vehicle which land along a ballistic trajectory. Myasishchev, on the other hand, began to develop a vehicle which would use aerodynamic surfaces during reentry.

Both vehicles would be sent into space on Korolev's No. 7, the famous [R-7] launch vehicle which was the workhorse of our space program for many years.

Contacts between OKB-1 [Korolev] and OKB-23 [Myasishchev] were maintained not just between their directors. Korolev's associates frequently consulted with OKB-23's workers on space research topics. In visiting each other, they discussed many specific matters—for example, the effect of radiation on space vehicles. Jointly with OKB-1, the specialists from Myasishchev's firm designed the mass of their own vehicle so that it would conform to the capabilities of Korolev's launch vehicle. Their calculations indicated that, with an ascent into an orbit 400 kilometers high, the vehicle could weigh up to 4.5 tons. If, however, the altitude were to be increased by 100 kilometers, then it would be necessary to reduce the space plane's weight by half a ton. The specialists from Korolev's OKB gave their colleagues recommendations regarding the vehicle's heat shield. The heat-resistant covering would have to protect nearly 40 percent of the aerospace vehicle's surface from the enormous heat loads which would arise during its return to Earth.

The space plane would begin a controlled descent from an altitude of approximately 40 kilometers. It would be capable of conducting a lateral maneuver of up to 100 kilometers, with a horizongal-range of up to 200 kilometers. A turbojet engine provided a 100-kilometer reserve of maneuverability in the lateral and longitudinal directions.

The basic parameters of the future aerospace vehicle were discussed with M. V. Keldysh and other scientists. In April 1960, a meeting was held on that matter between the leading specialists of the aviation sector and representatives from OKB-23.

Design studies were performed on various versions of the vehicle. Even a method for a helicopter-style landing was examined. The designers meticulously studied different types of heat-shield materials, as well as all kinds of unique methods for cooling the vehicle, including the use of molten metal for those purposes. Nor did they overlook new types of fuel, including hydrogen and fluorine.

Specifications were issued for the development of an ejection seat. It, together with the so-called portable emergency reserve and the parachute system, was not supposed to weigh more than 160 kilograms. That's a very rigid requirement if you take into consideration the fact that the seat would have to withstand 25 g's and operate flawlessly in fierce cold or tropical heat. The seat's development engineers had to ensure the pilot's complete safety during ejection. The seat would fly out of the vehicle exactly two seconds after the hatch cover shot off.

The second half of 1960. In the United States, the work on preparing a spacecraft to be launched along a ballistic trajectory to an altitude of up to 200 kilometers with an individual on board is in full swing. But not everything is going smoothly for the American specialists. The launch dates are being pushed back. In the USSR at this time, the work on the Vostok craft is being wrapped up in Korolev's special design bureau.

Myasishchev is seeking his own path into space. His developments are sometimes so original that they are decades ahead of their time. Only much later will we see something similar in the reusable Shuttle and Buran ships. And, in light of that, the arguments of some Western specialists about Soviet borrowing of American technology become completely unconvincing.

The work on project "48" was facilitated to a large extent by the fact that experience had already been gained during the development of project "40." In order to lighten as much as possible the structure of the space plane, it was decided that foam ceramics would be used as the heat-shield material. That is an extraordinarily lightweight material, but it is highly brittle. The wing had to be made rigid so that the coating would not fly off. Therefore, the heat shield was incorporated, as it were, into the contour of the wing, in the form of tiles that were glued on. The joints' heat resistance was ensured by the use of special techniques. Testing of the heat-shield covering on a stand in the stream of a jet engine showed that the covering operated reliably.

All the new design finds required complicated theoretical calculations and the solution of a large number of mathematical equations. Computer hardware in the current sense of the term did not exist yet, and, therefore, in order to determine the distribution of the temperatures in the wing, it was decided that so-called electrodynamic analogy would be used. Essentially, that consisted of breaking the structure down into components and replacing them with electric analogs, which made it possible to make an electric circuit and then calculate the thermal loads on it. That is just one example of how many of the most complicated problems were solved in a creative fashion. Even back in those remote years, Myasishchev's design bureau understood the advantages of laminated plastics. Such composite materials are just now appearing on the scene.

The structure of the space plane's nose consisted of a hull made of graphite, into which diaphragms made of a niobium [columbium] alloy were set and which was filled with expanding foam ceramics. That approach, devised by two of the design bureau's associates, was protected by a patent. But other finds—particularly, the system of heat-shield tiles, which has already been mentioned—remained unregistered, and our country's claim to it was thereby forfeited. In 1977, the American designers used tiles for covering the Shuttle ships. Myasishchev was still alive then. Just what feelings did the designer have about their using the tiles? He died in 1978, leaving behind a mass of new projects and ideas which, quite possibly, may still be realized.

"Vladimir Mikhaylovich," recalled OKB-23 associate L. L. Selyakov, "was a unique individual. He was known as a hospitable host who really loved to receive guests. He had a way not only with people, but also with animals. In the evenings, he sometimes told his dachshund about various unpleasant things that had happened, and he talked things over with it.

"But, at work," continued Selyakov, "he was a punctual, organized person who stood up well under life's adversities. It is curious that, even in Tsagovskaya prison, he invariably showed up for people in a clean shirt, completely ironed.

"I don't know exactly why Vladimir Mikhaylovich was arrested. They said that he supposedly traveled to America as part of some delegation. So when someone needed to concoct a reason, Myasishchev was faulted for that.

"But, in general, Vladimir Mikhaylovich was an honest person who did not tolerate lying of any kind. He never passed off anything that was bad as something that was good, he never acted hypocritically, and he was never a yes man. Just like every talented person, he had his share of people who were envious of him. I believe it was that very independence of character which was the reason that his official career endured such drastic breaks. But, for all that, he always remained true to his technical projects and ideas. Literally up to the end of his days, he continued to work a reusable craft. He began at one point with a small Buran and ended up taking part in the work on designing the cabin for today's large Buran."

In the period from March through September 1960, in OKB-23, they had a good idea of how the space plane should look. Moreover, that's when they calculated the so-called mass-to-size characteristics for two versions. The overall mass of the equipment amounted to around 600 kilograms, and that of the payload, to 700 kilograms, including the weight of the pilot in his suit and the ejection seat. Some equipment was taken from the Vostok craft—for example, the Zarya communications system.

What was Myasishchev's aerospace plane like? It was a small craft with a launch mass of 3.5 tons. Its length was around 10 meters, its height ranged from 2 to 4 meters

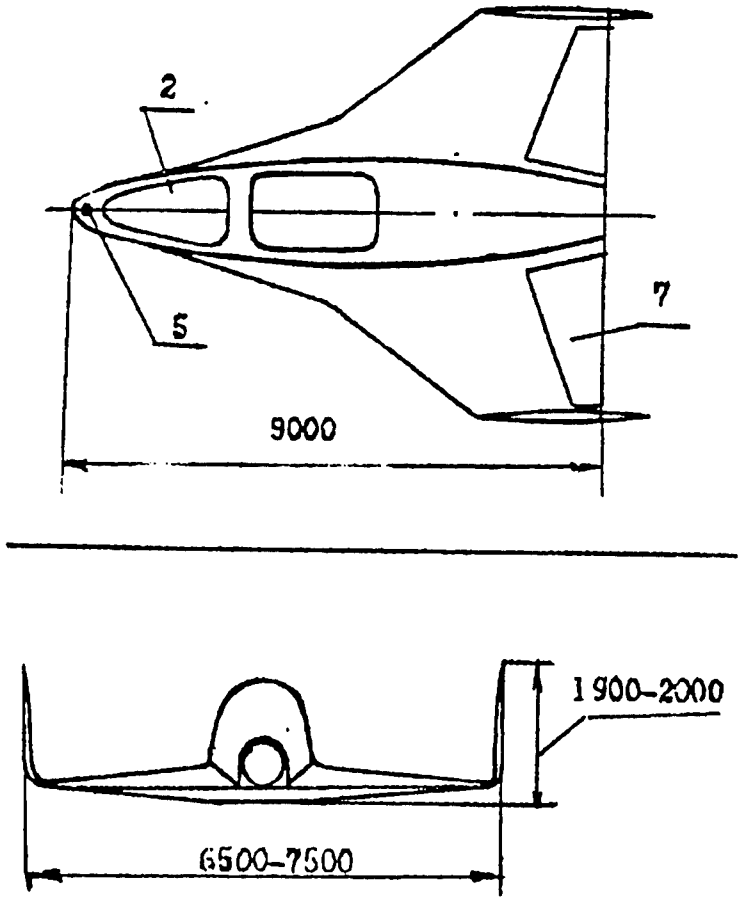
(depending on the version), and its wingspan was 7.5 meters. Its launch into orbit was virtually the same as the lift-off of Korolev's Vostoks and Voskhods.

But the descent was somewhat different. During reentry, at an altitude of around 40 kilometers, the space plane would begin maneuvering in order to get to its own airfield. When the plane had dropped down to an altitude of approximately 8 kilometers, the pilot was supposed to eject. The pilot would activate the main parachute system anywhere from 8 kilometers in altitude down to 3 kilometers. If the main parachute system didn't trigger right away, the reserve parachutes would start operating at an altitude of 2 kilometers. The vehicle, however, would land independently on special skids.

Landing a cosmonaut separately from the vehicle was also possible, incidentally, on the Vostok craft. And that is precisely how Yuriy Gagarin landed. But, in accordance with some secret canons, that "was not disclosed" in the press for decades. Just what were the advantages of the method Myasishchev had selected? Its chief merit was in the realization of the idea of reusability. The space plane could be fueled up, have other components added and be sent into orbit again. The idea was enticing, but the technology of the time had not yet caught up to the it. The simpler versions were given preference.

While it was designing the space plane, Myasishchev's design bureau also did work on its own launch vehicle, a three-stage rocket with a parallel arrangement of the units. The rocket was to be a little more than two times more powerful than Korolev's Vostok launch vehicle.

However, the next harsh break in the designer's fate occurs now. In late 1960, at the decision of N. S. Khrushchev, OKB-23 is arbitrarily incorporated into another organization—OKB-52. Academician V. N. Chelomey headed that collective. V. M. Myasishchev, who has fallen out of favor, is appointed the head of TsAGI.




Myasishchev's Space Plane

**The aerospace vehicle developed in OKB-23 was a small, swept-wing plane with a flat bottom. In plan view, it had the shape of a nearly equilateral triangle. Essentially, it was a slightly elongated flying wing. Control of gliding in the atmosphere was accomplished using elevators. The work on this plane was given the name Project "48." The project was officially approved in December of 1959.**

But even in its new position, the collective, now under the supervision of V. N. Bugayskiy, continues to work on space-related research, participating in the development of the Proton rocket and the Salyut orbital stations.

Today, Myasishchev's former design bureau—now knowns as Salyut—is headed by General Designer D. A. Polukhin. Space research is becoming the primary research performed by this collective. The design bureau is participating in the development of orbital stations and 20-ton transport craft on which modules like Kvant and Kristall are based. Today, those modules are functioning as part of the Mir orbital complex. Salyut is also busy with upgrading the Proton rocket. Soon its lift capacity will be increased to 24 tons from 21. That is for low orbits. For high orbits—up to 40,000 kilometers above Earth—the Proton will be able to lift satellites weighing 4.5 tons.

For the approaching market, the design bureau is developing new types of space products and is seeking new partners. Under discussion, in particular, is the development of the so-called orbiting factories. The manufacture of semiconductors, drugs, optical glass, and biological preparations will be possible on them. The firm has a solid product for that—the 20-ton Tekhnologiya module. Unlike other such vehicles, that module has a large recovery capsule. For what purpose? The capsule contains some of the on-board furnaces in which, for example, semiconductors are produced. Upon completion of the cycle of operations, the capsule is dispatched to Earth. There, the products are removed from the furnaces, which are then reloaded with new raw material and sent back into orbit.

Tekhnologiya represents a present-day space technology. On Salyut's drawing board, however, is an even more powerful orbiting factory. Its launch mass will be 100 tons. To date, only the Energiya superrocket is capable of lifting such a unit into orbit. A lot is being said now about the fact that that rocket has, essentially, turned out to be unemployed. Well, that new factory could become a worthy payload for Energiya.

The Soviet space program has followed a complicated path in its development. That path has had its ups and downs. The present stage is, quite possibly, having the most trouble. Like a well-tuned mechanism, the space program is moving forward for now, but that motion is largely due to inertia. Without some injection of new energy, the machine will stop sooner or later. Our space program's leading positions have been earned at the expense of the labor of thousands of enthusiastic people. Vladimir Mikhaylovich Myasishchev was one of them. I would hope that their devotion will be a model for us and will help us to survive the hard times and to lift the space program to new heights.

[Boxed material at the top of the page in source]

**Gagarin's space suit [photo not reproduced] is that same unearthly orange garment which so frightened the women kolkhoz workers who saw the first cosmonaut in a plowed field. Over the 30 years which have passed since that time, the designers have created quite a few different space suits—including anti-g suits and EVA suits.**

**The development of the reusable Buran ship was preceded by a great deal of research. It was conducted both on full-scale models and on "miniplanes" that had been scaled down in size by several factors. The geometrically similar Bor-5 model displayed at the exhibition [To the Stars-91] is just one of those vehicles. There were others before it—including especially the the Bor-4 model, which had been sent into space four times. Two of those models splashed down in the Indian Ocean and were observed by Australian researchers, and they generated their own kind of "shuttle boom" in the press—numerous articles about the Soviet reusable-ship development program. The two other Bor-4 vehicles splashed down in the Black Sea. Their flights, strangely enough, coincided with the tales of numerous eyewitnesses of successive visits to Earth by extraterrestrials.**

**The Bor-5 model is a copy of the Buran ship which has been scaled down by a factor of 8. This plane, strictly speaking, did not go aloft into space. It performed a so-called suborbital flight. A rocket lifted it to a high altitude, after which the plane, together with the launch vehicle's final stage, made its way toward earth, gathering more and more speed. At one point, it achieved orbital velocity, after which the stage and the plane separated, and Bor-5 made an independent landing on a landing strip.**

**Photo caption**

1. At the "To the Stars-91" Exhibition: ...the geometrically similar model of the Buran ship—the Bor-5, which was launched on 22 June 1988. [photo not reproduced]

## Spaceplane Designers Outline Research Trends

*PM1707110291 Moscow PRAVDA in Russian 4 Jul 91 Second Edition p 6*

[Article by A. Tupolev, aircraft general designer; G. Zagaynov, chief of the Central Aerohydrodynamics Institute; D. Ogorodnikov, chief of the Central Aviation Engine Building Institute; and V. Chepkin, power unit general designer, under "Science Fiction Blueprints" rubric: "To Mars by... Airplane"]

[Text] "Earth is the cradle of reason. But we cannot live in the cradle forever," our great compatriot K.E. Tsiolkovskiy said.

Experience gained in space exploration over a comparatively short historical period already demonstrates fairly graphically that if used rationally for the purposes of establishing communication and navigation systems, producing new materials and compounds, and studying the earth's surface, space opens up huge possibilities for mankind.

A fundamentally new field that has been studied intensively of late by the world's leading aerospace firms is a single-stage reusable spaceplane.

Extensive programs in this field are being conducted in the United States, Japan, and other countries. These programs are set to run for 10-16 years, and it is intended to spend between $3.5 billion and $16 billion on them. In the experts' opinion, the implementation of these programs will make it possible not only to develop a fundamentally new class of flying machines, but also to develop promising technologies that will set the standard for these countries' technical development at the start of the 21st century.

Today the Soviet aviation industry has available the scientific and technical groundwork that would enable it to set about designing an experimental spaceplane. Bearing in mind the importance of this program for the country's technical development, and also the considerable expenditure required to implement it, USSR President M.S. Gorbachev has decided to submit the basic outlines of this program for open discussion by the scientific and technical community, and also to examine possible ways of organizing international cooperation. It also seems advisable to us to hold hearings on this program in the appropriate USSR Supreme Soviet committees and commissions. This program should be open and subject to glasnost, which will undoubtedly assist its implementation and help to attract the country's best scientific and engineering forces to the realization of the project.

In putting forward the basic outlines of the program to construct a spaceplane, we should note that in this instance the basic principle of aviation is preserved, and the aircraft will be capable of making a total of 100-150 flights in space. Finally, it is "single-stage" because the same vehicle that took off from the airfield goes into orbit. There are no detachable sections here.

This spaceplane will take off from an ordinary airfield and provide a regular service to deliver payload into near-earth orbit at a considerably reduced unit delivery cost.

The spaceplane will be multipurpose, with unique system features: short reaction time, general-purpose capability, and self-contained and flexible utilization.

The question arises: Why did we earth dwellers not open up space using spaceplanes before? The scientific and technical standard of aerospace designs was not up to the task of building a spaceplane. Besides which, the development of technology is determined by the economic, ecological, political, and conceptual demands which society makes of it. In future we inhabitants of the earth will be required to significantly increase the number of "earth to orbit to earth" flights and to increase the flow of freight while reducing costs. It is also essential to improve the ecological characteristics of space rocket systems, to put a stop to the pollution of space with spent sections of rockets, and to significantly reduce or even do away with territories that have been set aside for the spent stages to fall to earth. Therefore the leading world powers are intensifying their search for new and more efficient ways of reaching near-earth space.

The most promising of all the areas being looked at, albeit the one that necessitates solving the most complex problems in order for it to be implemented, is the single-stage fully reusable spaceplane. For several years now, our organizations have been studying the possibility of implementing this idea in a spaceplane that is being designed at general designer A.A. Tupolev's Experimental Design Bureau.

Work carried out by designers and research conducted by scientists at the N.Ye. Zhukovskiy Central Aerohydrodynamics Institute show that an aircraft of this type could be constructed.

The construction of a spaceplane will become possible only as a result of exceptional and revolutionary achievements in materials science, technology, engine construction, instrumentation, and extensive application of supercomputer-based computer systems. Let us take the design of the aircraft's airframe as an example. In aviation design there is a parameter that characterizes weight efficiency,—the fuel ratio, that is to say the amount of fuel the aircraft can carry on board at takeoff. Previously we established the record with the Antonov An-25 aircraft, which on flights to the United States via the North Pole carried a fuel load equivalent to 54 percent of its takeoff weight. But the An-25 had an airspeed of only 200 kilometers per hour. A very large quantity of fuel needs to be stored on a spaceplane—over 65 percent of its takeoff weight, and in view of a number of requirements this fuel could be liquid hydrogen, which is 11 times less dense than kerosene. The fuselage must be of a considerable size. Moreover, as it accelerates in the atmosphere, the spaceplane reaches speeds 10 times greater than that of aircraft, and the surface temperature, particularly on the leading edges, can exceed 2,000 degrees centigrade. It is necessary to come up with an inconceivably lightweight and durable design capable of withstanding high temperatures. Calculations show, for example, that in order to work, the design for a fuel tank with cryogenic liquid hydrogen (at a temperature of minus 250 degrees centigrade) must weigh just 20 kg per square meter of surface area, whereas the current design of a similar sort of nonreusable tank on the "space shuttle" weighs over 30 kg per square meter.

It is obvious that in order to come up with such a unique design, it is not enough just to improve the strength and heat resistance properties of existing materials. The manufacture of fundamentally new materials with vastly improved properties is required, for example alloys or compounds with the strength of titanium and the density of aluminum that work at the sort of temperatures to which modern heat-resistant steels are subjected.

Research that has been carried out has demonstrated that this is not science fiction. There are a number of

ways in which the aforementioned requirements can be implemented. Coordinated work must be done by a number of enterprises in the aviation industry, metallurgy, and other sectors, and specific material and financial resources must be allocated.

All modern systems of placing space vehicles in orbit use rocket engines powered by on-board fuel and oxidizer reserves. Atmospheric air is certainly not used and only creates dangerous resistance. If atmospheric air is used as the oxidizer for engines, on the aircraft principle, the efficiency of the power unit can be increased many times. True, this requires air-jet engines which must work effectively at flight speeds several times faster than those of the fastest modern aircraft, and must also be twice as light as current models.

The fuel, too, must be considerably more efficient than kerosene, which is what today's aircraft normally use. The most suitable fuel is liquid hydrogen, which not only has a high calorific value but also provides essential cooling for engine and aircraft components.

World aviation science and technology have now really arrived at the possibility of constructing such engines. At least specimens of the necessary heat-resistant materials exist, flights have been made in aircraft powered by liquid hydrogen, and the theory and methods of computer studies have been developed and supercomputers constructed for this purpose.

Work on the multiple power unit is being coordinated by the Baranov Central Aviation Engine Building Institute, and the chief design facility is the A.M. Lyulka Experimental Design Bureau.

I would like to note the most important feature of the design and construction of advanced aerospace technology: This work, although it involves enormous expenditure, is known to be profitable. Its profitability consists not only and not chiefly in the falling costs of space programs and air transportation. It is profitable because of the tremendous development in new materials technology, computer technology, automation, and so forth. A typical example of this is the American moon flight program. Conceived not as a commercial program but merely as a scientific and prestige program, it paid for itself twice over owing to the extensive use of its advanced technological achievements in ordinary terrestrial applications.

Here are just two examples of the potential use of future technologies.

For spaceplane engines the extensive production of the latest heat-resistant alloys and compound materials is necessary. The use of these materials in conventional aviation will make it possible to reduce the weight of engines and make them more economical. And all other engineering technology, for example in the automotive sphere, could acquire fundamentally new properties and a new appearance, and will differ from current technology just as the modern transistor differs from the valve radio of 50 years ago.

Liquid hydrogen, which is essential as a fuel in spaceplane engines, could, if produced industrially, be used as the ideal ecologically clean fuel in transport power plants and the power industry on the ground.

It has to be said that our country is now in the forefront of aerospace technology. Our theoretical developments and designs for spaceplanes are not inferior to foreign ones, and in some respects our scientific and technical groundwork is unique. Suffice it to recall the Tupolev Tu-155 aircraft with its liquid-hydrogen-powered engine, and our rocket engines.

What will a spaceplane offer the inhabitants of the earth? Those in possession of spaceplane technology will dominate the aerospace product markets of the 21st century. No wonder the United States, which has made the greatest progress in studying this problem, is not keen to cooperate with other countries. It is counting on a monopoly and on surpassing all its competitors by a wide margin. After all, it is already evident from the example of new materials that the program will result not just in the construction of a spaceplane, but also that these materials and technologies will find a use in machine tool manufacture, the automotive industry, shipbuilding, metallurgy, engine manufacture, and so forth.

The spaceplane itself will be a multipurpose system with unique potential. The fact that it can be reused to deliver various payloads into space with a short turnaround time will enable the flow of "earth to orbit" freight to increase while offering the possibility of converting some of the production capacity currently producing nonreusable delivery vehicles.

A spaceplane with an inspection module could be used to carry out on-the-spot inspection of space devices in order to monitor the fulfillment of international agreements. The experience we have gained in designing and testing the experimental Tu-155 aircraft powered by liquid hydrogen and liquefied natural gas demonstrates that the use of cryogenic fuel has potential. Initially this will be natural gas—a Tu-156 using this is already being built. Then, when cheaper methods of producing liquid hydrogen have been developed, this will in turn be brought into service in conventional aviation.

Thus the infrastructure for producing, storing, and fueling up with liquid hydrogen will be created at many airfields. A fleet of spaceplanes could then be based at this network of airfields.

A spaceplane construction program is expensive and lengthy, and therefore a rejection of a confrontational approach and a rational international distribution of

labor would allow countries to reduce their expenditure by cutting down on parallel and duplicate work, and would also speed up the manufacture of the efficient new types of technology that everyone on earth needs.

Needless to say, the spaceplane could also be used to tackle various military tasks, which is why this work was formerly top secret. But here we need a rational approach. We are not going to disclose our technological achievements, but the people should know what their money is being spent on. All the more so as the fact that research is being done into this problem is not particularly secret—all the advanced powers are working in this field.

## Developmental Work on 'Space Plane' in Progress

*LD0407203991 Moscow Radio Moscow World Service in English 1200 GMT 4 Jul 91*

[Text] Work has started in the Soviet Union to develop a space plane of the 21st century. Taking off from an ordinary air field,it will ensure regular supplies for orbiting stations. This flying machine must be extremely lightweight, durable and resistant to very high temperatures of about 2,000 degrees Celsius. It will use liquid hydrogen as a fuel.

Since the development of a space plane will require large funds, an open discussion of the program is expected in the Soviet national parliament.

## Soviet-U.S. Research on Ozone Layer

*LD0108222691 Moscow TASS in English 1119 GMT 1 Aug 91*

[By correspondent Vyacheslav Serikov]

[Text] Leningrad August 1 (TASS)—The ozone layer enveloping the Earth has been described as the planet's biological shield warding off the Sun's harsh ultra-violet radiation. Research already done by Soviet and U.S. scientists formed the basis for the work of Soviet and American researchers-members of the Earth science working group who plan joint experiments and exchange of observation data obtained in space and on the Earth's surface.

Space research done in Leningrad is justly acclaimed the world over. Starting with the first space missions, Leningrad-based space researchers launched wide-scale projects to study fundamental and applied problems of space science.

At present, scientists in the Soviet Union and other countries are most interested in studies of the Earth from space and of the atmospheric gas layers.

American researchers have accumulated considerable experience in this field. Their investigations in the Antarctic have revealed that the ozone ring's thickness is not uniform. The Antarctic is the continent of ozone holes, caused by the circumpolar air current influencing the distribution of near-Earth gasses.

Soviet scientists, for their part, have reached a conclusion that the atmosphere is mainly ruptured over the spacecraft launching sites. But these local holes are insubstantial and are soon filled.

Joint research in this field has provided the basis for the creation of the Soviet-American on-board instruments and decoding methods and for conducting a number of satellite-related experiments.

"Consequences of Iraq's arson with regard to Kuwait's oil wells were also considered by specialists in space research," the Soviet-American working group's leader, Professor Anatoliy Buznikov told TASS.

"Together with American colleagues, we have been watching from space the movement of the smoke and carbon dioxide tails [as received]. On the basis of these observations we supply recommendations to areas towards which the toxic cloud is moving."

In addition to ecologic observations, specialists from the two countries are working in the field of space instrument making, astronomy, astrophysics, biology and medicine. The results of their efforts are stored in a data bank accessible to Soviet and U.S researchers.

## Preview of U.S.-Soviet Mission to Study Ozone Layer

*PM1908133591 Moscow Central Television First Program Network in Russian 1800 GMT 14 Aug 91*

[From the "Vremya" newscast: Report by A. Gerasimov and V. Pankratov, identified by caption]

[Text] There are less than 24 hours to go before the launch of the Tsiklon rocket which will put the Meteor-3 satellite in orbit. Our correspondent reports from the Plesetsk Space Center.

[Gerasimov] The slogan behind me—a quintessentially Soviet piece of propaganda—can now be read quite calmly by any foreigner. U.S. and Soviet space research specialists have pooled their efforts to provide a common defense against a common enemy. The gas in these aerosols is destroying the ozone layer of the earth's atmosphere. Scientists say that it'll only take another 30-40 years of not treating the ozone layer properly and we'll be in real trouble from the sun's ultraviolet light. So we have decided to protect ourselves. Political barriers have been swept away and two state organizations—our State Committee for Hydrometeorology and NASA—have completed work on a unique project. A device to monitor the overall ozone content of the atmosphere has been installed on the Soviet Meteor-3 satellite, which is to be launched tomorrow. This device was developed by the U.S. spaceflight center. The unusual alliance between Soviet rocket power and U.S. high technology is the first major joint project since the Soyuz-Apollo mission. Before the launch both sides have discovered that they can learn from each other. The NASA representatives admired our specialists' level of knowledge. And the very strict control over dust particles in the assembly and test building was new to the Plesetsk Space Center. No doubt it is this painstaking attention to detail that is the secret of the Americans' very high standards. Well, you live and learn! And this kind of lesson is another real benefit to be gained from cooperation. Still to come is the joint processing of the information on the ozone layer produced by the American device. Incidentally, the information our scientists will receive will be the Americans' only payment for the use of the Soviet satellite. Both sides will profit—although it's inappropriate to mention profit when we're talking about problems that concern the whole planet.

## U.S. Officials at Plesetsk Cosmodrome for Launch

*PM2208114991 Moscow Central Television First Program Network in Russian 1800 GMT 15 Aug 91*

[From the "Vremya" newscast: Report by A. Gerasimov and V. Pankratov, identified by caption]

[Text] [Announcer] The Tsiklon booster rocket was launched today in the Soviet Union, putting the Meteor-3 satellite into orbit. Our correspondent reports from the Plesetsk Cosmodrome.

[Gerasimov] This is the first time that Americans have been admitted to the northern cosmodrome—thanks to the TOMS Meteor-3 joint project. While opening up to the whole world and engaging in cooperation—and not only in supplying raw materials—our state is also giving up totally unnecessary secrecy. We have already talked about the presence of military men at cosmodromes. Today, when the booster rocket was being brought out, the guests were given an honest warning about the dangers to people near the launchers. They eat up fuel. It's a bad joke. This is certainly one of the paradoxes of scientific progress. With one hand man does good works—here we have a joint program to save the earth's ozone layer—but with the other man poisons the land. This is an international problem. Suffice it to say that every shuttle launch destroys tens of millions of tonnes of ozone, whose disappearance will now be recorded by U.S. instruments aboard a USSR satellite. Why a Soviet satellite?

[S. Keller, NASA deputy administrator, in English with superimposed Russian translation; identified by caption] We had no available satellite to carry our instrument into the right orbit. The Soviets have helped us to do this.

[Ch. Kout (name as transliterated), project head, in English with superimposed Russian translation; identified by caption] The level of technology and the quality of the Soviet side's work fully met all our requirements.

[Gerasimov] This unexpected optimism is certainly one of the better reasons for bringing into being the idea of a global system for keeping an eye on the earth's ecology from space.

[V. Zakharov, deputy chairman of the USSR State Committee for Hydrometeorology, identified by caption] I don't believe in God but thank God it has ended like this.

[Gerasimov] So, Meteor-3 begins its work of safeguarding the ecology.

## Meteor-3—TOMS Ozone Mission Launched

*LD1508211691 Moscow TASS in English 1936 GMT 15 Aug 91*

[By correspondent Vladimir Khrustov]

[Text] August 15 TASS—A Soviet rocket blasted off Thursday carrying a U.S. satellite device on a joint mission to study the thinning ozone layer of earth's atmosphere.

The Cyclone rocket was launched from the Plesetsk cosmodrome carrying a Soviet Meteor-3 satellite equipped with the device.

"We have actually embarked on the conversion more than 30 years ago", General Mikhail Kalinkin, deputy chief of the main center of space parts measuring complex, told TASS. He said that over these years, specialists of the center prepared [f]lights of 225 spacecraft for scientific and economic purposes. These were satellites of the "Meteor", "Resurs", and "Okean" and other series providing information for 17 various ministries and departments.

"In other words, the Flight Control Center prepares all space flights, except for manned flights", he said.

Meteor-3 satellites meant for [remote] probing of near-Earth space are included in the state meteorological space system and supply information received not only in the visible, but also infrared and ultraviolet ranges.

The satellite put into orbit on Thursday carries the U.S.-built total ozone mapping spectrometer or TOMS. It will be used for measuring overall ozone content in the earth's atmosphere.

The Meteor-3—TOMS project is meant for two years. The TASS correspondent learned this from Stanislav Samarskiy, deputy chief designer of the satellite and deputy technical director of the project. The project is being implemented by scientists from the Soviet Central Aerological Observatory and the All-Union Institute of Electrical Engineering. Specialists from NASA's Goddard Space Center participate in the project from the U.S. The main task is to continue monitoring the global ozone content by measuring its content in upper layers of the earth's atmosphere.

The device will be used to observe a large hole in the ozone which usually appears over Antarctica from late in August to early in October and decreases by mid-November. The joint Soviet-American program will help implement provisions of the Vienna convention on the protection of the ozone layer.

## TASS Reports Meteor-3 Orbital Parameters

*LD1508161091 Moscow TASS in English 1552 GMT 15 Aug 91*

[Text] Moscow August 15 TASS—The Soviet Union today launched a meteorological satellite, Meteor-3.

Blasted off by a Tsiklon (Cyclone) booster from the Plesetsk space port, the probe is to gather hydrometeorological information, and help upgrade the system of weather-forecasting observations from space and master measuring and optico-mechanical scanning television and radiometry equipment, geophysical research instruments and methods for the remote-sensing of the atmosphere and surface of the earth in the interest of various Soviet economic sectors and science.

In keeping with the Soviet-U.S. agreement on cooperation in the exploration and uses of space for peaceful purposes of April 15, 1987, and with the July 25, 1990, agreement between the Soviet Hydrometeorology Committee and the U.S. National Aerospace Administration, the satellite also carries U.S. equipment for mapping the condition of the ozone layer.

The satellite was delivered to an orbit with the following parameters:
Initial period of revolution—109.4 minutes,
Maximum distance from earth—1,219 kilometers,
Minimum distance—1,196 kilometers,
Inclination—82.6 degrees.

The launch of the Soviet meteorological satellite with U.S. equipment is a joint contribution by the USSR and the United States to resolving the problem of protecting the ozone layer and to carrying out activities that are connected with observing 1992 as the international year of outer space.

## Meteor-3—TOMS Project Will Be Last Meteor Satellite Launch

*PM1608134191 Moscow Central Television First Program Network in Russian 2111 GMT 15 Aug 91*

[From the "Television News Service" newscast: Report by R. Oganesov and V. Nikitin, identified by caption]

[Text] The Meteor-3 automatic spacecraft was launched from the Plesetsk Space Center today. It will be researching the earth's ozone layer. This marks the start of the largest Soviet-U.S. space project since the Soyuz-Apollo mission.

[Oganesov] The TSN film crew is here at the mission control center for scientific and national economic satellites—the first time journalists have been allowed in. This is the nerve center of the Soviet-U.S. Meteor-3—TOMS project. Hitherto the center had been top secret. Nobody knows why. Possibly because it is run by specialists drawn from the Defense Ministry Space Troops. Yet it deals with purely civil missions such as weather forecasting, ice monitoring, mineral prospecting, environmental monitoring, and an emergency early-warning service. Its information is used by 17 civilian ministries. According to specialists, the annual economic benefit from using spacecraft runs to almost 2 billion rubles [R], including R500-700 million from weather forecasting alone. Despite the obvious benefits, the state is cutting back on appropriations for space research, thereby doing irreparable damage to the development of world-class technology. And such technology is very thin on the ground in our country. Moreover, civilian ministries are suffering cutbacks too, and their space budgets are no exception. [Video shows general designer Yu.V. Trifonov, identified by caption]

[Trifonov] We're losing workers. We're losing specialists. Our associated plants have virtually stopped work already. This will be the last Meteor satellite to be launched. There's no funding for any more. It's hard to say what the future holds for the Weather Bureau and the forecasts you see on TV. When the finance minister received instructions from Comrade Doguzhiyev to find us some money, he replied: "Let them sell their information." Unbelievable! It's an insult—such information isn't sold anywhere in the world. It's a matter of principle that meteorological information is free of charge.

## U.S.-Soviet Study of Ozone Layer Lauded

*917Q0157A Moscow PRAVDA in Russian 15 Aug 91 Second Edition p 3*

[Article by Professor V. Zakharov, deputy chairman of the USSR State Committee for Hydrometeorology: "The Ozone Scout"]

[Text] The words "ozone layer" sound at present like a planetary alarm. A unique and frail atmosphere which has given rise to "the mode of existence of protein bodies," which to us is our multifaceted and still surprising, largely mysterious life, is facing the threat of destruction. "A hole" in its thinnest and most sensitive cover, the ozone layer, raises many issues with regard to the further existence of our ocean of air. It is increasingly jeopardized by the industrial operations of humanity. The composition of the atmosphere is changing right before our eyes due to the discharges of gas and aerosol particles. The concentration of these poisonous emanations surpasses all acceptable limits.

However, the notorious "ozone holes" became the most acute warning to earthlings. If this is indeed a destructive process capable of causing harsh ultraviolet rays to break through, we may foresee the subsequent disruption in the condition of ecological and biological systems, as well as climatic changes and global warming, in combination with changes in the concentrations of other gases. Increased ultraviolet radiation levels unfavorably affect the health of people, primarily their immune systems, by weakening the resistance of the organism to skin tumors and infectious diseases of various kinds. The influence on the immune system depends to some degree on the skin color and place of residence.

The perception of the changes underway in the physical environment and of their global nature has resulted in international cooperation and the creation of international scientific projects for counteracting this threat.

The joint Soviet-American project Meteor 3-TOMS [Total Ozone Mapping Spectrometer] is one such project. Its implementation will make it possible to monitor and study changes in the ozone layer of the atmosphere on a global scale.

A joint statement by the presidents of the USSR and the United States, in which it was noted that studying and preserving the ozone layer is one of the priority tasks of cooperation, gave the impetus for initiating this project.

The USSR State Committee for Hydrometeorology [Gosgidromet] and the U.S. National Aeronautics and Space Administration (NASA) are the leading agencies for this project.

In keeping with this project, it is planned to put yet another Soviet meteorological satellite, Meteor-3, into orbit from the Plesetsk space launch complex using our booster rocket. In addition to standard and scientific-research equipment, the TOMS spectrometer designed by NASA will be installed with a view to studying and

mapping the global distribution of ozone over our planet, as well as accumulating data on its climatic variations. The project has been in preparation for more than two years, and has been implemented successfully, thanks to the striving to cooperate and the efforts of scientists, engineers, and technicians, primarily of the USSR Gosgidromet, the USSR Ministry of the Electrical Equipment Industry and Instrument Making, the USSR Ministry of Defense, and the U.S. NASA.

During this period of time, a number of meetings between Soviet and American specialists have been held, which made it possible to resolve organizational, scientific, and technical issues of compatibility of the TOMS device with the on-board system of the Meteor space vehicle, telemetry, equipment for the collection and discharge of information to acceptance centers located on the territories of the USSR and the United States, and processing and exchange of information.

These meetings have also made it possible for the specialists of the two countries to learn more about the issues and prospects for building satellite instruments, creating artificial satellites of Earth for hydrometeorological and geophysical research, and the organization of services for launching and controlling space vehicles. The main point is that these meetings reinforced their confidence in each other.

It should be noted that cooperation between the scientists of the USSR and the United States in the sphere of studying variations in the ozone layer dates back several years. Joint and international seminars have been held, programs have been implemented to study the ozone layer in the Arctic and the Antarctic using laboratory planes, Soviet ground instrumentation, and American ozone probes on balloons at Soviet aerological stations at Hays Island Franz-Josef Land, and in the Antarctic at Mirnyy station.

The TOMS spectrometer is a second-generation satellite instrument. Its performance is superior to that of instruments previously used on Soviet and American satellites. It measures the content of ozone by comparing descending solar radiation and that reflected by the surface of Earth on six wavelengths in the band of 310 to 380 nanometer.

After drawing up global maps of ozone content, the most important task of the scientists is to determine to what degree changes in the ozone content are associated with activities of human origin, in particular, with the production and consumption of chlorofluorocarbons, to what degree they depend on natural geophysical and hydrometeorological conditions (solar activity, circumpolar vortexes, and so on), which is very important for adopting a further strategy for reducing the production and use of ozone-destroying compounds by humanity within the framework of the Vienna Conference on Protecting the Ozone Layer and the Montreal Protocol on the conference.

Before the development of satellite instruments for measuring ultraviolet radiation and ozone, these parameters were studied at ground stations using Dobson spectrofotometers (so named in honor of a scientist who was a pioneer in the area of ozone study) or instruments produced mainly in Canada and the Soviet Union. Despite their reliability, these data are insufficient because ozone is measured only immediately above the stations; the latter are situated mainly in the medium latitudes of the Northern hemisphere. However, ground stations are necessary for calibrating and tying in the data received from the artificial satellites of Earth because measurements taken there are more precise and make it possible to track variations in ozone during the course of a day.

The employment of TOMS is also useful for monitoring sulfur dioxide in the atmosphere. The compilation of these maps makes it possible to observe the volcanoes of the world regularly and to measure sulfurous discharges during their eruptions. A sequence of such observations over several decades will make it possible to come up with a more accurate estimate of the contribution of a stream of volcanic sulfur into the overall balance of sulfurous compounds in the atmosphere.

The implementation of the Meteor 3-TOMS project will become the largest USSR and U.S. project in space since the Soyuz-Apollo program. It is an example of mutual cooperation between the two countries in the interest of the world community.

## 'Molniya-1' Communications Satellite Launched 18 Jun

*LD1906102591 Moscow TASS in English 1017 GMT 19 Jun 91*

Moscow June 19 TASS—The Soviet Union on Tuesday launched the Molniya-1 communications satellite.

The satellite is aimed to maintain the telephone and telegraph radio communications system and transmit Soviet central television programs to receivers of the Orbita network.

The Molniya booster rocket put the satellite on the highly elliptical orbit with the following parameters:
Apogee—40,825 kilometers in the northern hemisphere,
Perigee—457 kilometers in the southern hemisphere,
Initial rotation period—12 hours and 16 minutes,
Orbital inclination—62.8 degrees.

## 'Resurs-F' Satellite Launched 23 July

*LD2407090591 Moscow TASS in English 0757 GMT 24 Jul 91*

[Text] Moscow July 24 TASS—A Resurs-F satellite wis launched in the Soviet Union by a Soyuz booster rocket on Tuesday.

The satellite carries equipment designed to carry out various-scale multi-band and spectrum-band photography to carry on the study of terrestrial natural resources for the benefit of various branches of the Soviet economy and accomplishment of tasks pertaining to ecology and international cooperation.

The satellite was put into an orbit with the following parameters:

—Initial orbital period—88.7 minutes,

—Maximum distance from the earth's surface (in apogee)—

261 kilometres,

—Minimum distance from the earth's surface (in perigee)—

195 km,

—Orbital inclination—82.3 degrees.

The on-board equipment is functioning normally.

Upon the accomplishment of the mission, the exposed film will be handed over to the State Research and Production Center Priroda of the USSR State Committee for Geodesy for processing and subsequent distribution of the obtained information among users.

## 'Molniya-1' Communications Satellite Launched 1 Aug

*LD0208085491 Moscow TASS International Service in Russian 0831 GMT 2 Aug 91*

[Text] Moscow, 2 Aug (TASS)—A regular 'Molniya-1' communications satellite was launched in the Soviet Union on Thursday [1 Aug]. It is designed to ensure the operational use of a long-distance telephone and telegraph radio-communications system, as well as the transmission of USSR Central Television program to isolated areas.

The satellite was placed into a high elliptic orbit by a 'Molniya' booster rocket with an apogee of 40,681 kilometers in the northern hemisphere and a perigee of 653 kilometers in the southern hemisphere. The satellite's period of revolution is 12 hours, 17 minutes, and its orbital inclination is 62.9 degrees.

## 'Resurs-F' Satellite Launched 21 August

*LD2208201991 Moscow TASS in English 2010 GMT 22 Aug 91*

[Text] Moscow August 22 TASS—The Soviet Union on Wednesday launched a Resurs-F satellite.

The satellite carries equipment to make multi-scale multizonal and specterzonal photographing to continue research of natural resources for the benefit of various economic branches of the Soviet Union, as well as to solve ecological problems and develop international cooperation.

The satellite was brought into orbit by a Soyuz booster rocket with the following parameters:

—Initial orbital period - 88.8 minutes,

—maximum distance from Earth's surface (in the apogee) - 272 kilometers,

—minimal distance from Earth's surface (in the perigee) - 195 kilometers,

—orbital inclination - 82.3 degrees.

The equipment is working normally.

After the flight, the exposed film will be brought to the Soviet State Research Center Priroda for development and distribution of information.

## Possibility of Determining the Reflecting Layers in the Troposphere Over the Ocean From Variations in Satellite Radio Signal Levels

*917Q0096 Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 315 No 4, Dec 90 pp 830-834*

[Article by A. N. Bogaturov, K. P. Gaykovich, A. S. Gurvich, V. K. Ivanov, S. S. Kashkarov, S. N. Krivonozhkin, A. S. Smirnov, V. D. reylikher, and B. M. Shevtsov, Institute of Atmospheric Physics, USSR Academy of Sciences, Moscow; Pacific Ocean Oceanological Institute, Far East Branch, USSR Academy of Sciences, Vladivostok; Institute of Radiophysics and Electronics, UkSSR Academy of Sciences, Kharkov; Scientific Research Radiophysical Institute, Gorky]

UDC 538.56:551.51

[Abstract] Satellite radionavigation signal levels were observed in various regions of the Pacific Ocean. The processing of those observations demonstrated in many cases an almost periodic modulation of the primary interference pattern that was caused by reflection of stratified inhomogeneities of the troposphere and that had not been seen earlier. The unsual modulation period was two-20 times less than the period for the primary interference pattern and differed from other distortions in its regularity. The altitude of the efficiently reflecting stratum can be determined from the ratio of the modulation period to the period of regular interference, and features of its horizontal extent can be determined from the duration of the modulation that is observed. The satellite-borne TRANSIT radionavigation doppler system was used in the measurements reported in this paper. The satellites are in near-polar and near-circular orbits of 1,100 km altitude, and their transmitters emit two coherent signals continuously, at carrier frequencies of around 150 MHz and 400MHz. A total of 240 observations were made on the 11th cruise of the r/v

*Akademik Aleksandr Vinogradov* (1988) and the 16th cruise of the r/v *Akademik Aleksandr Nesmeyanov* (1989). The researchers concluded that the strong quasiperiodic modulation they noted was due to additional interference at the point of reception of the waves reflected of the stratus. A simple model they constructed did enable them to estimate the altitude of the reflecting stratum ($H = h\theta_i/\theta_m$, where $H$ is the altitude of the stratum, $h$ is the altitude of the antenna, $\theta_i$ is the period of the primary interference structure, and $\theta_m$ is the period of the strong quasiperiodic modulation), but it could not explain details of the fine structure of the signal or features noted at two wavelengths. That would require consideration of a great many factors affecting radiowave propagation—such as angular and frequency dependence of reflection coefficients, multipath effect, etc.—and a better description of the wave field. Figures 3, references 4: 3 Russian, 1 Western.

## Imaging of Stream Currents in Neva Bay on High-Resolution Radar Images

*917Q0097 Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 315, No 2, Nov 90 pp 337-340*

[Article by S. V. Viktorov, L. L. Sukhacheva, V. V. Viter, I. Yu. Postnikov, and P. A. Shirokov, Leningrad Branch, State Oceanographic Institute]

UDC 551.46.0:629.78

[Abstract] Operations performed from 25 July 1987 through 30 July 1989 with a synthetic-aperture side-looking radar operating at a wavelength of 10 cm aboard the Kosmos-1870 satellite produced a large number of radar images of the ocean surface with a resolution of 20-30 m in a 20-km swath. Analysis of radar images of areas of the Atlantic Ocean, the Baltic Sea, and large, land-locked water bodies testifies to the large amount of information contained in the images and to the wisdom of using those images in oceanographic research. That type of satellite-derived information is especially effective in problems involving regional satellite oceanography and local ecological monitoring. This article presents the results of the interpretation of a fragment of a radar image made from Kosmos-1870 on 26 June 1989 of Leningrad, its suburbs, and the eastern part of the Gulf of Finland adjacent to the city. The image is characterized by considerable heterogeneity, largely because the hydrological conditions of Neva Bay are quite complex and variable, and they depend on a multitude of factors, including atmospheric (baric) processes, the amount of water in the Neva, the state and phase of change of the surface level at any given time, and wind. Compounding that is the complex nature of a bottom relief that abounds in underwater channels, banks, shelves, and cribs. The phenomenon of the stream currents of the Neva's waters is graphically confirmed in the interpretaton of the images. Analysis of those images made it possible to produce a momentary picture of the stream currents in Neva Bay, to determine lengths and widths of those currents, and to identify the structure of the streams (areas) of strong currents. Figures 2, references 4 (Russian).

## 'Kursk-91' Experiment

*LD0707044291 Moscow TASS International Service in Russian 1454 GMT 6 Jul 91*

[By TASS correspondent Aleksandr Shchiglenko]

[Text] Kursk, 6 July (TASS)—Forecasting productivity of agricultural crops with the help of space photographs is just one of the directions of the "Kursk-91" international satellite-assisted experiment which started today near Kursk on the territory of the Central Black Earth Zone biospherical reserve.

For the first time this year along with scientists from the USSR, Bulgaria, Hungary, Germany, Czechoslovakia, Poland, Vietnam, and Cuba—the traditional research participants—colleagues from the United States will also take part in the work.

Scientists are to carry out complex observations of the biological productivity of the reserve's steppes, as well as arable land. By comparing characteristics of the same plots of land surface taken at different altitudes, scientists might find a universal "key" to deciphering space photographs.

Materials obtained in the course of "Kursk-91" will help to improve remote models for forecasting harvests, as well as changes in the natural environment influenced by the individual's activities.

## Commentator Urges Cutbacks in Space Program

*917Q0089 Moscow RADIKAL in Russian No 5, Dec 90 p 2*

[Article by Doctor of Technical Sciences Lev Golovin: "The Extraction of the Essence"; first paragraph is RADIKAL introduction; final two paragraphs are editorial comment]

[Text] **"In the West there are no revenues from space activity. But in our country there are, given the fact that we launch more satellites, while their operating life is shorter. All this looks strange"—such is the opinion of Doctor of Technical Sciences Lev Golovin, a specialist in space hardware.**

An entire generation in our country grew up believing that our country is in "the forefront of the development of space" and, therefore, scientific and technical progress as a whole. And indeed, who could dispute such unquestionable achievements of the Soviet Union as the launch of the first satellite, the photographing of the dark side of the Moon, and the sending of man into space? This spurt was due, first of all, to the existence in our country at that time of the most powerful launch vehicle, the R-7, a weapons platform that had been adapted for space launches. Large expenditures were not required for these first impressive results, and besides, the hardware was relatively simple.

However, subsequently, owing to the misguided zeal of our propaganda, which shouted at every corner about the great accomplishments in space being due to the advantages of the socialist system, we were drawn into a protracted space race with the United States. America began preparation for the flight of a man to the moon, striving to restore the fallen prestige of the country. It was an imposing program; considerable material and financial investments were required for the development of such sectors as electronics and optics. In our country we were unable to do this....

By the end of the 1960s, it was already clear to specialists that the Americans had passed us in space research, particularly in the creation of applied systems. But what we were nearly always first in over those decades was the number of launches and the placement of large payloads into space. Incidentally, we had always tended to develop very large aircraft (not just spacecraft) in our country, for our military-industrial complex never particularly worried about money. Today, we have the AN-225s, the largest airplanes in the world, the MI-26 helicopter, and the Energiya launch vehicle. And ahead is the project involving the Mir-2, the largest orbital station in the world, and a 20-ton communications satellite in geostationary orbit.

In recent times, because of the strained economic situation in the country, the questions have been coming up more and more often, how much is the space program costing us and do such vanities become us today?

In July of this year the weekly EKONOMIKA I ZHIZN published the materials of a "Delovoy klub" [Business Club] meeting, which was devoted to space economics. Representatives of many organizations and departments—but mainly of those which develop space hardware ("sellers"), and not those which use the fruits of the space program ("buyers")—participated in it. That is a pity, because it is how the consumers appraise the economic impact that would be a good thing to find out. The discussion was, let us say frankly, one-sided: Those who spoke made statements about the great effectiveness of the work being performed which were boastful, but, unfortunately, hardly at all grounded. True, in the weekly EKONOMIKA I ZHIZN a table of the billion-ruble [R] economic profit from the space program was cited, but it was prepared by the Ministry of General Machine Building, no substantiations are cited, and, after all, a great deal depends on the methods of calculation that are used. All this greatly differs from the prevailing opinion of Western specialists that the commercialization of space does not promise rapid successes. They point out, in particular, that weather satellites and remote sensing systems will not become profitable until the second half of the 1990s. As for space-based manufacturing and the production of crystals and drugs in microgravity, the private sector in the United States has not displayed the anticipated interest—it turns out that entirely acceptable characteristics are achievable with ground-based production, with incomparably smaller expenditures. At present, only space-based communications systems are profitable.

Nevertheless, the representatives of the Main Administration of Geodesy and Cartography and the Planeta Scientific Production Association assert that their work on the remote sensing of Earth is bringing our national economy an enormous profit, the expenditures are being recovered almost ten times over. Well, all right then, all that is quite easy to verify if you convert those respected organizations to cost recovery. Let them make contracts with the users of information and themselves order and pay for the satellites and ground equipment which they need.

There is another area of space activity—basic scientific research. Hardly anyone will deny its necessity, but it would be worth it, perhaps, to try to reduce the spending as much as possible, in light of the enormous costs of projects. The results of that research are of interest to the entire world community, and the most complicated and expensive of projects could be effected through the efforts of a number of countries. But here business initiative is important, and the Main Administration for the Development and Use of Space Hardware [Glavkosmos] clearly does not have enough of it. In fact, China, which became a space power almost 15 years after we did, is launching all kinds of "foreign" satellites, but we have not been able to come terms with other nations, and A. Dunayev, chief of Glavkosmos, merely complains bitterly from time to time in the press about the unjust restrictions of the Coordinating Committee on Export

Controls. But who is to fight against this, if not Glavkosmos, especially now that the cold war has ended?

But the greatest expenses are connected, of course, with poor-return, if grandiose, space projects, particularly manned flights—everything that we inherited from the "ostentatious space program" of the Brezhnev era. Just take the Energiya-Buran system; thus far they have kept quiet altogether about its cost. In three years, the Energiya rocket has made just two flights, and Buran, one flight. What is next?

When developing the system, we, of course, directed our attention to the United States, which built the reusable Space Shuttles, which, incidentally, their owners are obviously not enthusiastic about. The Shuttle development program cost $10 billion, and their maintenance, regardless of the number of launches, requires every year another $3 billion. But the anticipated decrease in the cost of putting payloads into orbit has not happened. Today in the United States, a great many satellites are put into orbit by expendable boosters. The U.S. Department of Defense has given up on the use of the Shuttles, as it has on manned flights in general. But in our country, in addition to the Buran itself (incidentally, how many of them are there?), the Energiya launch vehicle has also been developed, which also costs, apparently, more than a billion.

True, the system has already been developed, and, as they say, why give up now? But today everyone knows that there is nothing for it to put into orbit. Well, OK, the Mir-2 station, which, as they note in the United States, will consist of 100-ton units—the first of which will go up in 1992—and which will not go into operation until the mid-1990s. Its cost is unknown to the Soviet public. The similar, but smaller American orbital station Freedom (which is being developed in extensive cooperation with other countries) will cost $37 billion. Its commissioning is planned for the end of the 1990s.

There are, in fact, other payloads for Energiya-Buran. Plans exist for orbital factories, a lunar base, and a mission to Mars. All of them, undoubtedly, are interesting, but their realization will require hundreds of billions of rubles. Can we really engage in all this today in our crisis situation, when far richer and more stable countries do not dare attempt such things?

Of course, there are people in this country of the military-industrial complex who are vitally interested in all that. But should their opinion be the decisive opinion in the matter? It would be only for the good of the country if we would confine ourselves to the already existing boosters, which put payloads of up to 20 tons into orbit and provide for all the needs of national economic, scientific, and military organizations. And we could postpone the development of space facilities weighing more than 20 tons. After all, in the end, 1 kg of a communications satellite costs the Americans $40,000-$90,000, putting that kilogram into low orbit costs $9,000, and putting it into geostationary orbit costs ten times as much. We probably have much the same cost ratios. It would be wise to mothball the Energiya-Buran system until better times, inasmuch as there is no vital need for its operation. Several of our scientists said that back before the start of its development.

And what we should focus our efforts on is on improving the quality of the equipment and the electronic and optical hardware of space systems. But judge that for yourselves: The 2,120-kg Gorizont communications satellite has eight repeaters and a service life of three years; whereas the American Intelsat 6, with approximately the same weight, has 38 repeaters and a service life of 10 years.

After having focused on improving the quality of radio electronics and its component base, we would decrease the number of satellites being launched; then the amount of work on the production of their components would also decrease.

Speaking at one of the meetings of the USSR Supreme Soviet, N. Ryzhkov named the figure of the spending on space in 1989—R6.9 billion. Earlier, in 1987, American specialists named a different figure for USSR spending for those purposes—$30 billion. But nearly R7 billion a year is an eloquent enough figure to be enunciated with some embarrassment.

Thus, in my opinion, a saving of several billion could be achieved by the following measures:

—mothball the Energiya-Buran system

—effect a carefully thought-out reduction of the number of military space systems

—cut back on the number of manned flights, and transfer applied experiments to unmanned vehicles

—convert space activity which concerns the remote sensing of Earth, meteorological systems, and other such systems to cost recovery

A. Solzhenitsyn recently expressed it all in just three words: "Space can wait."

*From the editorial office: More and more people today are realizing that the "great space accomplishments" are a part of the legacy of the stagnation times, like other colossal projects like the Baykal-Amur Railway Line or the diversion of rivers. But if, say, the activity of the Ministry of Land Reclamation and Water Resources has already been evaluated appropriately, the games of "the conquest of space" today are costing us a pretty penny. But they are screening themselves from indignant people with the "shield" of applied programs (communications, meteorology, navigation, and so forth), which make up only a small part of the "space kettle." And it does not matter, it is passing, the people's deputies are calming down....*

*We, of course, realize that other opinions about this problem also exist and we intend to continue the discussion.*

## Costs of 'Juno' Mission Far Exceed Income

*917Q0111 Moscow TRUD in Russian 21 May 91 pp 1, 4*

[Article by TRUD special correspondent V. Golovachev (Flight Control Center): "We Are Weak in Terms of Space Business: Some Thoughts in Connection With the Beginning of the Soviet-British Mission"]

[Text] The wealthy and prospering Soviet Union gave a generous gift, it would seem, to the not so wealthy and not so prospering Great Britain, when, three days ago, on 18 May, it sent Englishwoman Helen Sharman into space orbit with spacecraft commander Anatoliy Artsebarskiy and flight engineer Sergey Krikalev.

A little later about the gift. But for now, let us note that the launch went normally. During its two-day independent flight, the spacecraft gradually caught up with the Mir orbital complex in accordance with the usual profile. Then the most crucial approach and docking stage began. Plans called for it to be done in automatic mode. But the Kurs automatic approach and docking system provided an unpleasant surprise. One of its components failed. The crew had to carry out docking manually.

"Lena, you have to close the shutters on the viewport—there is too much light," Anatoliy Artsebarskiy said to H. Sharman as he assumed control of the craft.

The spacecraft completed the fly-around of the station and began to approach it. From aboard the spacecraft a television camera was transmitting a direct report from space to the Control Center. The orbital complex was easy to see against the backdrop of the clouds and the rotating earth. Artsebarskiy confidently and firmly guided the spacecraft to the docking port. The time was 1730 hours 46 seconds. Contact! Applause in the center. Everyone began to talk noisily, lifting the heavy tension of the past hour....

The international mission of the Soviet-British crew is arousing much interest not only in the United Kingdom (that is understandable, as Helen Sharman, smiling out from the pages of the newspaper, immediately became a celebrity in England), but also in other countries. First of all, space voyages have not yet become an ordinary thing. Second, it is noteworthy that someone who is not a professional pilot, but a process engineer in a candy factory (H. Sharman worked at the famous Mars Company) is taking part in the international mission on the Soviet spacecraft. Third, the world community is following with interest what is, no matter what they say, a unique competition in the commercial space arena between the USSR and the United States.

In this case, it must be noted, the commercial aspect of the Juno project has proved to be, to put it I guess a little more mildly, a bit weak. Of course, not everything in our lives is governed by money, and far be it from to suggest that the payback of every instance of international cooperation be measured in financial terms. But this time, the mission from the very outset was declared a commercial mission, and, thus, the monetary aspect merits some attention.

Recall that the United States, for every foreign astronaut who has flown aboard the Shuttle, has taken about $25 million. We, however, until recently, took representatives of other countries "up for a drive" in orbit almost free of charge. Now the situation is changing. For the flight of a Japanese journalist to Mir, we made more than $14 million. There were hopes that the Soviet-British mission would yield from $7 million to $15 million, but, we see, those hopes were not fated to come true. According of available unofficial information, the Soviet side will receive only $1.7 million—one-fifteenth the cost of a flight about the Shuttle.

I wonder why the English sponsors suddenly lost interest in this mission? Back in the early part of the year, Prof. H. Wolf, the science director of the Juno program, said at a press conference at the London Museum of Sciences that the number of applications and proposals for the performance of a series of experiments in outer space exceeded all our expectations. Of the total number of applications, 26 proposals were selected.

In general, so it seems to me, we are still not very skillful businessmen. There are a lot of things we're vague and confused about. Initially, the agreement on the flight of a British cosmonaut on the Soviet Soyuz-TM spacecraft and Mir orbital station was concluded in June 1989 between the USSR Main Administration for the Development and Use of Space Hardware [Glavkosmos], the Litsenzintorg All-Union Foreign Economic Association, and the British company Antiguera, Ltd. But in June of last year, in accordance with a decision of the USSR Ministry of General Machine Building, Glavkosmos USSR for some reason transferred its rights and duties of the Energiya NPO [Scientific Production Association]. Could it be that Glavkosmos did not want to take people up for a drive virtually free of charge? In November 1990, because of financial insolvency, Antiguera, Ltd., ceded its rights and transferred its obligations under the agreement to the Moscow Narodny Bank in London. A new agreement—between the Energiya NPO, Litsenzintorg, and the Moscow Narodny Bank—was signed on 2 December 1990.

Today, both Glavkosmos and the Energiya NPO want to engage in international activity and the making of contracts, but as a result, not nearly always can success be achieved. We are acting unskillfully not only in business, but also in the organization of our affairs. Last year, for example, Yu. P. Semenov, director of the Energiya NPO, conducted negotiations in the United States about the flight of an American citizen, and the western press

wrote about it. Our female journalist, however, got completely different information at the Energiya NPO and reported it, and embarrassment and a scandal ensued.

Things turned out a bit awkward this time, too: many Soviet journalists who are accredited at Baykonur did not get seats on the airplane that flew to the cosmodrome. I would like to ask Yuriy Pavlovich Semenov this: Did you consciously agree to this, or was it just another in the line of "unfortunate accidents"?

Standing at the gates of the Flight Control Center are Ikarus buses, on which foreign visitors are brought in. A car of the State Motor Vehicle Inspection Administration must also be there. It escorts the visitors on the trip about the city. I have had occasion to be a member of a delegation on trips to various countries, including Great Britain. And not once did a highway police car escort us. Why do we always prostrate ourselves before foreigners?

Let us return, however, to the international mission. Yesterday, after docking, the cosmonauts checked the seal of the link-up and opened the transfer hatch. The meeting of the hosts of the celestial house—Viktor Afanasyev and Musa Manarov—and the crew that had arrived was sincere, joyful, and friendly.

In the next five days, some 15 experiments are planned—medical and biological experiments, a biotechnology experiment, a production experiment, a geophysical experiment.

On 26 May, V. Afanasyev, M. Manarov, and H. Sharman will return to Earth, and A. Artsebarskiy and S. Krikalev will continue the space watch until early October. In the fall, a Soviet-Austrian crew will visit them. Electrical engineer Franz Fibeck and physician-anesthesiologist Klemens Lotaller, citizens of the Republic of Austria, are training for the future mission.

Flights of German, French, and, possibly, U.S. citizens are planned for 1992.

## Mir Station Program Viewed as Technical, Economic Failure

*917Q0125 Moscow KURANTY in Russian No 68, 11 Apr 91 p 5*

[Article by Boris Olesyuk, engineer, under the rubric "A Personal View": "The Price of Our Jaunts Into Space"; first paragraph is introductory paragraph in source]

[Text] **For one person to fly aboard the Mir station for one hour costs 50,000 rubles (R). A 24-hour flight costs more than R1 million, and a week-long flight exceeds R8 million. The Soyuz rocket costs the government 2-3 million rubles, and a Soyuz TM costs R7-8 million. So think about what the price is for our jaunts into space.**

On February 20, the third-generation Mir station celebrated its fifth birthday in orbit. The five-year anniversary of this "flagship" of the Soviet fleet went unnoticed. There are many reasons for that, but it seems to me that the main one is that our people have long lost interest in manned flights, and their faith in them has been seriously undermined. Why?

During the era of stagnation, articles in the press narrating the prosaic side of space were, as a rule, of a cunning, congratulatory nature. It was beaten firmly into our heads that in some things, and certainly in the manned space program, we were, are, and always will be "ahead of the all of the rest of the planet." The notorious word "first" became a fixed part of our lexicon and still remains in our heads. But today, only a supremely naive person would speak of the USSR's leadership in space. We have to be able to look truth in the eye. A country that is trailing along in the rear in scientific-technical progress, that is hopelessly behind the advanced nations by decades in electronics, computer technology, materials science, chemistry and other key fields, cannot be in the vanguard of space technology.

It is still too early to make a full assessment of how well the multipurpose Mir scientific laboratory has done on its watch; but it could be useful to do an intermediate analysis of its five years of operation.

But first let us remind the reader of the concept held by our scientists and engineers for the development of the manned space program. The fundamental development of near-Earth space by man is possible only if large, long-term, permanently manned orbital stations are created. They must have modular construction. Powerful rockets are to lift specialized modules into orbit where, moored to the main unit, they make up a single structure. Such an orbital station can function for many years.

Today Mir is a prototype of such complexes. It is equipped with six docking ports, and it is meant to be the central part, the nucleus of a large orbital complex. The plans were to attach five modules to the station in two years. Fully assembled, it would have a mass of 125 tons and would look like a gigantic cross. Six to ten cosmonauts were to live and work in that large stellar home.

The construction of that unique orbital complex been going on now for five years already. Although the complex is not yet fully assembled—two 20-ton modules have yet to be added to the structure—one can safely say that there, in the space suburbs of our planet, a grandiose, extremely complex engineering structure has been erected for which there is no analog in either the domestic or world history of manned spaceflight. In its size, mass, power output, and duration of operation in manned mode, the Mir complex surpasses the first and only American orbital station, Skylab. For comparison, it is enough to cite two figures: the Mir complex is 33 meters long and weighs as much as 85 tons; Skylab was 25 meters long and weighed 77 tons.

The complex has withstood the test of time and has proved its stability and its hardiness. And everything would be just fine if it weren't for one important consideration. If we are to be completely objective, we must

admit one extremely unpleasant fact: in creating today's Mir complex, we have only approached the level of hardware and technology the Americans had on Skylab, and that in 1973. No matter how you look at it, there is only one clear conclusion: we are 15-17 years behind.

We still have a solid lead in only the duration of our manned flights. Moreover, we have obtained valuable information about the responses of the human body to a prolonged stay in weightlessness. Our doctors are well aware that man can live and work in space for a year without damaging his health. The module method, which includes a series of rocket launches with subsequent dockings of modules to the main unit, has been officially approved. By the way, work is under way in the United States to create a permanent orbital station that weighs several hundred tons. American specialists are showing great interest in the Soviet experiments in orbit, and they are borrowing from our experience in assembling Mir. They are analyzing our mistakes and our successes very scrupulously. After all, space station Freedom will be built with the same modular method.

Meanwhile, the Soviet manned spaceflight program, whose directors have thus far been unable to substantiate the economic efficiency of the spending on space research, has serious flaws and has proffered some annoying miscalculations and mistakes. Any flight into space with people is expensive. It is about ten times more expensive than an unmanned flight, per kilogram of payload. The true cost of the entire Mir orbital complex is a closely held secret: the information is, thus, not public property. And maybe that's because the complex and expensive Mir program is far from complete in many aspects. The economic impact of its implementation is zero. No matter how strange it may seem, the treasury has made no profits from the billions invested in the program. A multitude of problems have become woven together in a tight knot, and some of them have not lost their urgency even today. Why is this so?

The orbital station was born with difficulty, amidst torments, and in unexplained haste. Failures constantly dogged it. And they began here on Earth. The station had not yet undergone the comprehensive testing called for in the plans at the firm that gave birth to it, the Energiya NPO [scientific production association], and no permanent scientific equipment had yet been installed in it, when the command came from the top: send Mir to the cosmodrome. The directors of the space department decided to make a present of the new station to the next party forum, even though Salyut-7 was still fully efficient. As the sad experiment with Salyut-7 showed, the "last of the Mohicans" could serve the space program for a few more years.

The designers had no choice but to complete construction of the basic unit in orbit, in flight. The first crew that visited Mir debugged its systems in 50 days. But the "bank" was empty, and cosmonauts Leonid Kizim and Vladimir Solovyev had no choice but to shuttle over to the nearby Salyut-7 spacecraft (luckily there was fuel). Some 400 kilograms of scientific gear was delivered from there to Mir.

The creators of the orbital complex entertained the hope that in two years they could complete full assembly of the structure. That did not happen. The Khrunichev Machine Building Plant in Moscow, which was manufacturing the modules, came under heavy criticism for not meeting deadlines. A new phrase, "late completion of space projects," gained currency.

Clearly, I would not be mistaken if I suggested that the extremely old former aviation firm is being blamed for everything unfairly. Our economy is on the verge of total collapse. The plant in Fili was tied by a thousand threads to enterprises scattered all over the country. In such conditions, could it be expected to operate with the rhythm and precision with which it had operated before? I think the answer could only be a clear no.

The first three modules just barely managed to dock with Mir. The events in the final stage of rendezvous developed as if part of a scenario written by the same person. Not one module was able to dock with Mir on the first approach, a problem that never occurred with the Progress craft. All the maneuvers had to begin all over again. That cost both time and fuel. Here the grievances were justified, and they needed to be presented to the specialists of the Salyut design bureau.

The fact that the useful life of the station is nearing its end is a source of alarm and apprehension: its assured service life ends in 1992. But there are still a great number of unresolved problems on the complex. If the pace of assembly of Mir remains the same as it has been, it seems to me that there's really no need to send the remaining modules into orbit at all. But when do they plan to launch those envoys of Earth that have been sitting around for a pretty long time by now? The fourth module is supposed to go this year, and the launch of the fifth module is planned for 1992.

And now, in all seriousness, here is the question of questions: For what reason did we undertake the construction in orbit of such a massive space structure? Answering that question is more complicated than one can imagine. I myself am troubled by that question, although I know that there is no unambiguous answer.

I must allow myself a small digression. We have erected the world's largest electric stations on our rivers, we have dug a canal in the Central Asian desert a thousand kilometers long, and we have built the railroad artery of the century—the Baikal-Amur line. And all of that was done not in the name of mankind, as was proclaimed, but for the good of the mythical "advanced socialism." What have the "great feats" we have performed led us to? What benefit has man gained? The answer is obvious. We have destroyed millions of hectares of productive lands and hayfields. We lost an extremely valuable product—our supplies of fish. A unique creation of

nature, the Aral Sea, is almost completely dead. And what cargo is transported on the Baikal-Amur railway? No one knows.

The wave of gigantomania rolled right up to the space department and overwhelmed it. Tipping their hats to the times and fashion, they begin to marvel at the "great constructions."

But what practical use has the flight of Mir been to the people, what has it given them? The orbital complex is generously equipped with a great variety of scientific and production gear, but standing watch on it, as with Salyut-4, are just two cosmonauts. A minimum of six persons are actually needed, however.

Instead of vigorously conducting basic research and solving problems that are in the interest of the national economy, the space workers must spend a great deal of their time on maintenance work, tuning things up, loading and unloading Progress craft, and doing EVAs to fix problems. One gets the impression that the main job of the cosmonauts is to repair, repair, and repair. And that's what they do day after day. Only one-third of the immnese scientific-technical potential of the complex is being used. Five years have passed, and as before, we are running in place.

And as strange as it may seem, this is all on account of a transport craft. The good old Soyuz, a craft that was designed by a design bureau that was around while Korolev was still alive, a craft that has faithfully and conscientiously served for about a quarter century, has long been waiting for a worthy replacement. It is hopelessly outdated, all its capabilities are used up, and it is incapable of performing the duties it is charged with. Judge for yourself. Soyuz can deliver a maximum of three individuals to Mir. But then it can't bring back anything produced in space. There is no second mooring spot for Soyuz. The aft docking port on Kvant is designed for Progress craft. How can this vicious circle be broken? Somewhere in an Energiya NPO design bureau, a new craft is being designed. When it will go into space, God only knows.

The crux of the program, the indisputable trump card of the designers, should have been the complex of electric furnaces they had hoped to use to begin experimental industrial production of unique materials for the needs of microelectronics and drugs with special properties. But no shop, and certainly no factory, has ever materialized in orbit. Why not?

Space equipment, as we know, must be reliable, durable, and simple to control. The furnaces don't come near to meeting all the criteria. They break down frequently, and something is especially wrong with the electronics. The cosmonauts repair the electronics, but after the next melting they are out of order again.

From everything that's been said, the question logically arises, What must be done to lift our manned space program from the quagmire it finds itself in?

As of late, people have been saying increasingly more often that our space program can be saved if we set up a single coordinating agency similar to America's NASA. The proposal merits a great deal of attention. After all, look at how many departments we have that deal with manned flights. But there should be only one manager. We need an integrated concept. We must develop, and the Supreme Soviet must approve, a broad, promising national program of manned flights.

Experience suggests that we cannot manage without such radical measures. The manned space program should occupy its proper place in the life of the country.

## Afanasyev, Shishkin Interviewed on Space Budget, Policy

### Afanasyev Defends Space Program

*917Q0131A Moscow EKONOMIKA I ZHIZN in Russian No 16, Apr 91 pp 6-7*

[Interview with Sergey Aleksandrovich Afanasyev, consultant of the USSR Ministry of Defense, by EKONOMIKA I ZHIZN special correspondent N. Tarasenko, under the rubric "12 April, Space Program Day": "Space Economics: Achievements, Problems, Prospects. S. Afanasyev: 'The Rain of Gold' is a Myth"; first three paragraphs are source introduction]

[Text] **The first artificial Earth satellites and the near-Earth-orbit flight of Yuriy Alekseyevich Gagarin, the first pilot-cosmonaut in the world, opened a new era in the history of mankind.**

**Since that memorable April day, 30 years have passed. Today, under the conditions of the emerging market, our space program is on the verge of an essentially new stage of its development. Basic scientific research of the universe is being linked more and more with the solution of specific terrestrial problems.**

**The dialog our special correspondent N. Tarasenko had with S. A. Afanasyev, a consultant of the USSR Ministry of Defense, and USSR Minister of General Machine Building O. N. Shishkin concerns how the space industry came about and what the economic problems of the sector are.**

**[Tarasenko]** For many years the space industry was behind an iron curtain of secrecy. Only today are we beginning to find out about the real state of affairs. Sergey Aleksandrovich, you are one of the people who were there at the beginning of this sector. Therefore, I would like to find out how the "space" ministry originated. There are many assertions that money always flowed to your enterprises in "a rain of gold."

**[Afanasyev]** The USSR Ministry of General Machine Building was established 26 years ago. By the ukase of the Presidium of the USSR Supreme Soviet of 2 March 1965, I was appointed minister, and I worked in that position for 18 years. From the very beginning, the sector

was conceived as an integrated sector capable of solving on its own all problems related to the development of rocket-and-space technology—from scientific research and design work to the series production of our equipment. The ministry consisted of the rocket-and-space enterprises proper, engine plants, and control system and instrument plants, as well as whatever special technological design offices and design bureaus, scientific research institutes with pilot plants, bench-test facilities, and test ranges that were needed. The creation of a broad management system, the focus of scientific manpower, and the intense work of those in the sector made it possible, in the final analysis, to develop rocket-and-space technology at the world level and ensured strategic parity with the United States.

All questions connected with the formulation of long-range programs and with the approval of specific five-year and annual plans were settled in close contact with the USSR Ministry of Defense and the USSR Academy of Sciences. We always devoted particular attention to the technical level of our product. Items were not allowed to be produced if they were inferior to foreign analogs.

We also produced a large number of consumer goods: tractors, televisions, refrigerators, radio-phonographs, tape recorders, vacuum cleaners, power saws, washing machines, and medical equipment.

Priority was given to questions involving the financing both of space programs and programs for consumer-goods production. We studied carefully all the suggestions of the organizations, chose the most efficient suggestions, and calculated the production volumes and the appropriate financing for each individual area.

All that was coordinated with the client and hundreds of subcontracting organizations. And only after careful analysis did we go to the government with our proposals about what financing was needed. There was never enough money—both then and now. Individual developments and programs had to be cut back, or the dates for their implementation had to be postponed.

The constant problems with the financing of operations required measures to regulate the distribution of the appropriated monies by research area and contractor. Due credit must be given to the economic services of the sector, which enabled the development and introduction of "The Unified System of Planning, Accounting, Reporting, and Day-to-Day Management of Scientific Research and Experimental Design Work in the Sector," which made it possible to spend the appropriations from the state in a proprietary manner.

The sectorial service for the technical-and-economic analysis and evaluation of the estimated cost (price) of scientific research and experimental design work holds an important place in the system. No developer can bypass this service. The efforts at economizing begin with the substantiation of the project and the choice of the most "inexpensive" version in the early stages of designing. The estimated cost of the project undergoes a "Cost-Effectiveness" technical-and-economic evaluation.

That's why the "rain of gold" is a myth that can impress only dilettantes and politically near-sighted people. Unfortunately, such misinformation is taken at times as the truth by some of our people's deputies, who work de facto against the space program with no grounds to do so.

By comparison with U.S. spending for space, USSR spending has always been severalfold less. That issue has already been covered in our weekly (No 38, 1990). Moreover, the annual allocations of the sector for space have always been much less than the constantly increasing needs and assignments of the five-year plans. Take a look at the published graph.

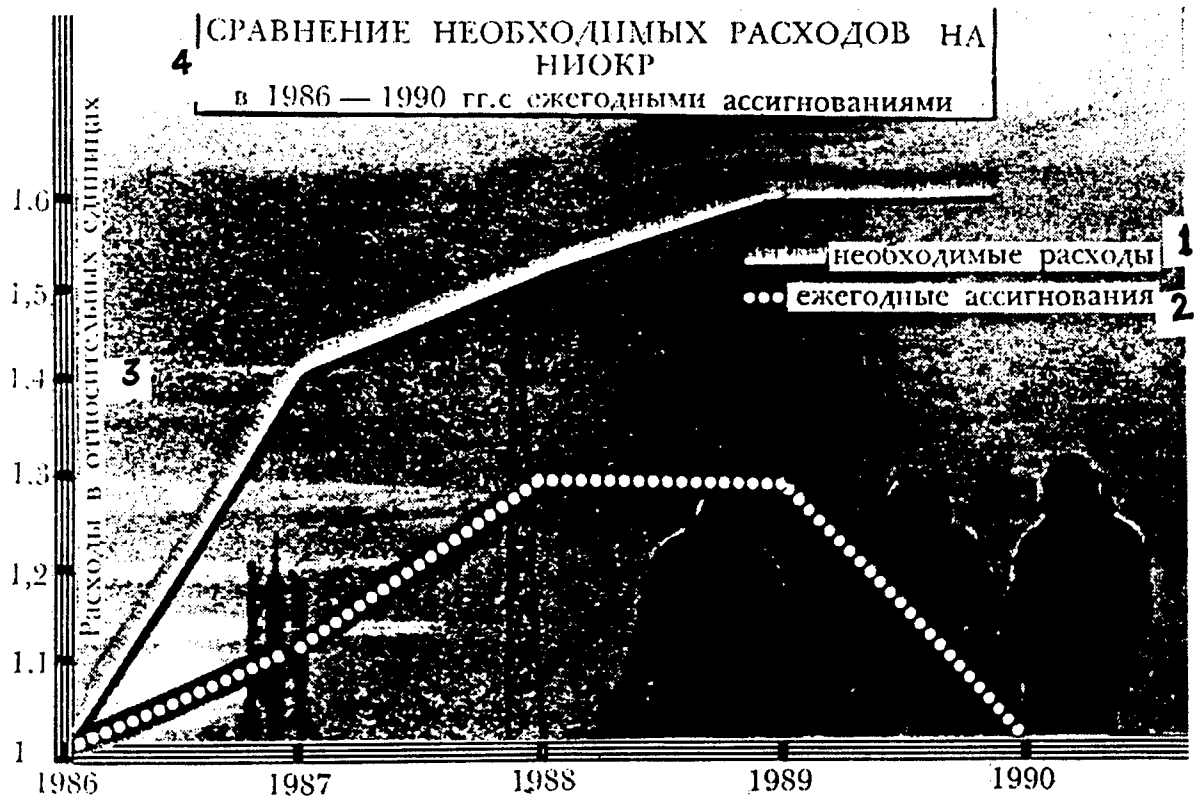
From 1986 to 1990 the anticipated spending for scientific research and experimental design work in comparable prices was 84 percent of the needed level of allocations for the fulfillment of the five-year plan.

**[Tarasenko]** Recently, a great many articles have appeared in the press on the "political games" that are played in the space program. Here are just a few examples. N. S. Khrushchev orders S. P. Korolev to launch Layka into space on the eve of the October anniversary. In 1981 the Soviet-Bulgaria Interkosmos/Bulgariya-1300 artificial Earth satellite was launched. L. I. Brezhnev was personally interested in the project. But all it took was for the political scene to change, and the working vehicle was shut down, and its active life ceased. Do you think that the politicization of the space program has hindered its development?

**[Afanasyev]** The formulation itself of the question is fundamentally incorrect. Such fabrications have a negative bent against the truly great space achievements of the Soviet people, which, in essence, contributed largely to the change of the political picture of the world in the middle of our century.

The launch of the first artificial Earth satellite made an impact in politics that no other scientific-technical achievement had made. It's no accident that the political scientists of the world divide the history of the 20th century into the "pre-Sputnik" and "post-Sputnik" periods. Unfortunately, Soviet historians and philosophers have devoted very little attention to that phenomenon. Our political leaders at the time rose to the occasion and made full use of the political capital that the creators of Soviet rocket-and-space technology put at their disposal.

N. S. Khrushchev did not order S. P. Korolev "to launch Layka into space on the eve of the October anniversary." It's just that, knowing that the work on satellites in our country was being conducted on a quite broad front, the then-leader expressed a wish: we need to show the world that the launch of the first satellite was not just luck, but the result of a systematic scientific program that Soviet scientists have begun on the study of space. The easiest thing for Korolev to do would have been to launch a




Key: 1. Needed spending—2. Annual allocations—3. Spending, in relative units—4. Comparison of the needed spending for scientific research and experimental design work in 1986-1990, with the annual allocations

second satellite, one similar to the first satellite, and the assignment would have been fulfilled. But, believing in the creative capacities of his own collective and related collectives, he decided to do what no one as yet has ever succeeded in doing: without conceptual or preliminary design, in close collaboration with scientists, planners, designers, technicians, and workers, he developed, in less than a month, an essentially new spacecraft that once again astounded the world. And when the people of the planet observed in the sky, with their own eyes, the handmade stars that were developed in the Soviet Union, many myths that had been created by decades of cold war and that could not at times be destroyed by political declarations, or notes, or statements at the United Nations, came crashing down.

If the launch of satellites and lunar probes, the first flight of man into space, the first flight of a woman cosmonaut, and the first walk in space in a space suit—all pioneering achievements that were the basis for all today's areas of the space program—could be called "political games," then we should be proud of the fact that we conducted such games, because all of mankind profited from them.

We, who are engrossed today by our domestic problems, have in many respects already lost our sense of reality and have nearly convinced ourselves that in our country everything was and is bad, while in other countries everything is splendid. But that doesn't help in the least to iron out world problems. Although the crises in areas such as ecology, energy, information, food, and weather recede temporarily, later they spread with new force. And only the space program will be able to solve them once and for all. That is why, throughout the world, its financing is increasing. New projects and programs are being developed, involving more and more states and groups—from small firms to the largest multinational companies. The entire world is preparing to greet the international space year, and not simply as a noisy holiday, but as serious international work that is preparing a new breakthrough in the large-scale development of space. And only we, in the birthplace of space programs, have been forced today to "wash" that sector out.

Today, our space program is actually the only sector of the national economy that remains at a state-of-the-art level. And to undermine the potential that has been created means to become like savages who are incapable of using a modern aircraft that has come into their hands, except to rip the skin from it to patch their huts and to make a lot of decorations from the other parts. It's these current debates over space program that are political games in the worst sense.

## Shishkin on Role of USSR in Space Market

*917Q0131B Moscow EKONOMIKA I ZHIZN in Russian No 16, Apr 91 pp 6-7*

[Interview with Oleg Nikolayevich Shishkin, USSR Minister of General Machine Building, by EKONOMIKA I ZHIZN special correspondent N. Tarasenko, under the rubric "12 April, Space Program Day": "Space Economics: Achievements, Problems, Prospects. O. Shishkin: The Complex Orbits of the Market]

**[Tarasenko]** Soviet astronautics has covered a glorious path. Oleg Nikolayevich, what role did the ministry play and what place did it take in the establishment and development of this most important area of the man's life?

**[Shishkin]** The breakthrough in the development of space technology had already been made by the time the USSR Ministry of General Machine Building was formed. The new ministry was assigned tasks that were more complicated and that required the development of basic and applied scientific research, the expansion of cooperation, and the establishment of a unique sectorial experimental and testing base.

The landing of an unmanned, soil-sampling vehicle on the Moon; the creation of a satellite communications system; the development of manned orbital complexes; and, finally, the creation of the Energiya-Buran space shuttle system—that's just a short list of the tasks accomplished by the sector. Moreover, in past, a number of space systems were developed for the USSR Ministry of Defense—primarily surveillance, communication, relay, navigational, and geodetic information systems. Today, they constitute the basis of the national systems used for monitoring adherence to the treaties and agreements involving the reduction of strategic and conventional arms. The use of those systems in the interests of the Armed Forces of the country increases their effectiveness by one and a half-to-twofold.

Centralization of management has helped create unique, modern experimental-testing facilities—an aerodynamic facility, a strength-testing facility, and a temperature-and-vacuum facility (which simulates space conditions), facilities, moreover, that are not inferior to the experimental facilities of the leading space powers of the world.

At present, the ministry coordinates the work and supports the interaction of scientists, developers, and production workers via intraministerial and intersectorial cooperation. More than 1,000 scientific research institutes, design offices, and plants from virtually all ministries and departments take part in the development of rocket-and-space technology. However, the basic purpose of the ministry has been and remains the formulation and implementation of a unified policy for the development of rocket-and-space technology in the interests of defense, science, and the national economy.

**[Tarasenko]** The country is going through a period of profound reforms in politics and the economy. Radical changes are also occurring in your sector. Tell us about the changes in the organization and management of space activity.

**[Shishkin]** The changes that are taking place in the country have also affected, of course, our sector. That is due primarily to the ongoing process of strategic arms reduction, which has required a change in the direction of the work done by certain design offices and plants. At the same time, 35 plants for the production of equipment for light industry and the food industry, plus 50 plants that supply medical equipment, have been transferred to the system of the Ministry of General Machine Building. Now, in addition to our development of launch vehicles and spacecraft, we have to reorganize the production processes at small plants that are using equipment dating to the beginning of the century. New technologies developed at enterprises of the space sector have been offered to those enterprises. The system used for financing our work has also been changed.

The total level of financing has decreased substantially. Nevertheless, under such difficult conditions we must, as before, create equipment at the world level.

We are using domestic materials, domestic equipment, and a domestic component base only, plus our own technologies. But our sector is working in broad cooperation with other sectors of the national economy and cannot but be susceptible to the processes of mutual influence. As a result of an enormous effort and the mobilization of all our capabilities, we succeeded last year in fulfilling the state order and the orders of departments. One means of stabilizing the work of the sector is to expand international cooperation, and primarily in the commercial use of space technology. All our previously closed enterprises are now economically independent and have the opportunity to have a broad presence on the domestic and foreign markets. In the process, the role of the ministry itself is also changing substantially.

**[Tarasenko]** Over a 30-year period, many billions of rubles were invested in the space program, but what kind of a return has there been? And then why is there such a discrepancy in the figures for the spending on the space program? For example, Academician V. P. Mishin states that, according to calculations of American experts, the USSR spent $30 billion on space in 1987. According to the data of USSR Glavkosmos [Main Administration for the Development and Use of Space Hardware], we spent about 7 billion rubles [R].

**[Shishkin]** Academician V. P. Mishin is apparently using the data cited in the newspaper TRUD, which contained

a report "Spending on Space," which was borrowed from a publication of the European Space Agency (an international consortium established in 1975 on the basis of the ESRO—the European Space Research Organization). The data on the spending for space programs by the United States and European countries are close to those that our specialists use.

However, the data on USSR spending for the development and use of space systems are overstated by severalfold, which, incidentally, is typical of western sources, particularly when the data involves USSR spending for solving defense problems.

Such cases involve the pursuit of opportunistic aims for influencing governmental or parliamentary circles when state-budget monies are being appropriated. USSR spending for the development and use of space hardware has always been one-third to one-half that of U.S. spending. Annual spending for space hardware in our country reached its maximum level of R6.9 billion in 1989 and was cited in the report of the chairman of the USSR Council of Ministers.

As a result of conversion and economic problems, that spending dropped in 1990 by more than 10 percent, as compared with 1989, while it grew by 8 percent in the United States.

**[Tarasenko]** Conversion and the spaca program. Oleg Nikolayevich, how would you appraise the initial results in the handling of such a difficult task?

**[Shishkin]** The rocket-and-space sector has devoted attention to questions of conversion since its creation. The first ballistic missiles were adapted for peaceful purposes—geophysical research. Many Soviet launch vehicles were developed on the basis of live missiles. Recall the famous "seven"—the first ICBM in the world. It laid the foundation for the development of an entire family of launch vehicles, which made it possible to begin the development of space and to develop a program of manned missions.

Today, we are going into the complex orbits of the market. In that connection, we regard the development of the space program as one important area of the diversification of defense production that is feasible without substantial alteration of the organizational-production structure that exists; we also regard it as a source of raw material resources, components, production technologies, and a production infrastructure. We feel that the most important area is the development of the latest technologies, materials, and designs that can be used in many other areas of machine building. Here, for example, are some specific results. The work that was performed when developing the Energiya-Buran system has resulted in the preparation of a consolidated list of scientific-technical achievements involving 34 enterprises of the USSR Ministry of General Machine Building, 32 enterprises of the USSR Ministry of the Aviation Industry, and more than 50 enterprises of other sectors that took part in the development of the system, to be introduced into the national economy. Thus far, more than 6,500 requests for familiarization and the transfer of technical specifications have been received from more than 300 enterprises and organizations of virtually all the sectors of the national economy. The cooperation of the interested parties has been organized with regard to all the requests, and work is being done to conclude contracts for the transfer and introduction of these achievements to the national economy.

Particularly noteworthy is the work on the production of medical equipment. The USSR Council of Ministers obliged the Ministry of General Machine Building (based on the enterprises of the former USSR Ministry of Instrument Making, Automation Equipment, and Control Systems, which are now part of it) to increase the production of that equipment from a level of R833 million in 1989 to R2.2 billion in 1995.

That comes to 63 percent of the planned total output of medical equipment in our country. The Ministry of General Machine Building is responsible for the implementation of science and technology policy in the area of prostheses and for meeting the needs of the population in prosthetic-orthopedic devices, wheelchairs, partially mechanized items, and appliances for the disabled.

Just one fact: our leading space organization, the Energiya Scientific Production Association, began development of prostheses. A little more than a year has passed, and medical personnel already have prosthetic-orthopedic devices that are in no way inferior to the best devices made by the world arbiter in that area—the German firm Otto Bock.

Considerable savings result from the use of special-purpose spacecraft as design and production bases in the construction of scientific and national-economic space complexes (used for biomedical research, the production of new materials and drugs, and the radar and spectral probing of Earth). For example, for complexes such as the Bion, Kuban, Nika, Resurs, and Foton, the savings resulting from the use of previously developed military spacecraft are as much as 70 percent of the money needed for their development.

Some envisage the possibility of a five-to-sixfold increase (as compared with 1990) of the volumes of annual services that are performed by the USSR Ministry of General Machine Building in terms of orders from various ministries, departments, and other users of space hardware. The first republic- or user-financed operations are under way in the use of space hardware to solve a number of social and national economic problems affecting Kazakhstan, Russia, and other union republics.

**[Tarasenko]** Is the sector capable of competing effectively with well-known firms on the world market of space services? What can we offer partners, and why are we not offering it?

**[Shishkin]** I will be frank—the role of the USSR on the world market of space services is considerably smaller

than our existing potential capabilities. Inadequate activity, in the past in combination with other adverse factors of an economic and political nature, led to a situation in which the market for space communications and navigation systems, as well as for launch vehicles, is filled mainly by the United States, the European Space Agency, and the PRC.

It should be borne in mind that the United States is doing everything possible to prevent a strong competitor from entering the world space market. In spite of our guarantees on inviolability and the creation of all the necessary conditions for the monitoring of those guarantees, the United States does not permit, for example, the delivery to USSR territory (for subsequent launch) of foreign spacecraft in which new American technology is used. We could offer our foreign partners a sufficiently broad range of services that are based on highly reliable domestic space hardware and, moreover, on favorable commercial terms. For example, a series of launch vehicles that ensure the placement into orbit of a wide range of payloads: from 1.5 to 100 tons.

We can support experiments aboard unmanned spacecraft and manned vehicles in the areas of materials science and production of ultrapure biomedical preparations. And contracts on the performance of such experiments have already been signed with several European countries. Higher resolution and quality are enabling photographs produced from space orbits by domestic spacecraft to compete successfully with the information produced by the American Landsat satellite and the French Spot satellite. The Soyuzkarta organization is becoming firmly established on the international market of space services.

In the near future, we propose to enter the world market with space technology products (drugs, semiconductors, and alloys). But, to be honest, for the present we are not satisfied with our international cooperation in cosmonautics. A great deal more needs to be done here.

**[Tarasenko]** Are the relations between the ministry and enterprises changing under the new economic conditions? Is the establishment in the sector of leasing and joint-stock enterprises, concerns, and consortia possible?

**[Shishkin]** The world experience in the development of complex sectors such as the space sector, shipbuilding, and nuclear energy in many developed countries shows that the effective implementation of programs in science-intensive sectors is impossible without coordination and the supply of program management with resources. Space activity in all countries is a function of the state, and a state-level agency manages it (NASA in the United States, NASDA in Japan, CNES in France). Naturally, in our country, where the scale and importance of space activity are quite great, there is also a need to delegate the functions of the organization, coordination, and monitoring of the progress of work, the drafting of long-range and current plans, and other functions to a state organ—the USSR Ministry of General Machine Building.

At the same time, conversion and the transition to market relations have predetermined the need for making goal-oriented structural changes. In our opinion, one possible form of management in the sector could be a concern in which strategic issues would be resolved centrallly, but management of enterprises would be flexible and mobile, and the enterprises would have a great deal of economic independence. Positive results could also be expected from associations. It would be advisable to establish joint-stock companies in the sector, first of all at small enterprises that make civilian products. Conversion and reorientation toward consumer-goods production has predetermined the diversification of production that has appeared in the establishment of a network of small enterprises.

If the problems of the space program are appraised as a whole, one thing is certain: its management needs improvement. Materials have been prepared on the establishment of a coordinating organ that has the rights of a client (like NASA of the United States) and finances operations in the area of space research. The space program is the national property of the country, and it should be the object of countrywide concern.

## Volga Branch of NPO Energiya Seeks Funds for Large Commo Satellite Program

*917Q0127A Moscow RABOCHAYA TRIBUNA in Russian 14 Jun 91 p 4*

[Interview with S. Petrenko, chief and chief designer of the Volga Branch of the Energiya Scientific Production Association, by Vladimir Babenkov; date not given (Samara): "Hello! They Are Calling You From an Airplane.... Specialists Assure Us: The Day Will Come When Fellow Soviet Citizens Will Be Able To Make Use of Such Service"—first two paragraphs are RABOCHAYA TRIBUNA introduction]

[Text] The equipment, which is necessary for communication with any point of earth, will be installed on so-called heavy space platforms. It is clear that one of the main tasks is to put this cargo, which is unheard of in the history of astronautics, into orbit. And they are working on it at the Volga Branch of the Energiya Scientific Production Association. In recent times along with other subdivisions they developed here a powerful rocket, about which in 1988 the entire world learned by the name Energiya.

I succeeded without lengthy formalities in meeting with S. Petrenko, chief and chief designer of the Volga Branch of the Energiya Scientific Production Association. And that is why a question immediately arise: What, do we now have nothing to hide?

[Petrenko] It is ridiculous for us to make a secret of what "they" have known for a long time. Owing to space

photography, analytical estimates, and much more our competitors have vast information. Therefore, we are now scrupulously keeping only the secrets of the designs of the basic assemblies, the know-how, the commercial secret. And, to all appearances, not unsuccessfully. Energiya is a unique booster that does not have analogs. Owing to its power and design peculiarities it can put into near-earth orbit a payload of more than 100 tons. At launch the thrush of the operating motors is about 3,600 tons.

[Babenkov] Is this rocket also intended for an unconventional load?

[Petrenko] Not entirely. The task of modifying the Energiya-Buran system was set for the Energiya Scientific Production Association and, thus, for our branch. After all, we should deliver satellite information systems based on heavy space platforms to an altitude of 36,000 km. This is the so-called geostationary orbit. Being in it, the platform hovers over a given point of the country and does not circle earth like a satellite. It is much more difficult to achieve a geostationary orbit than the already conventional 200-kilometer orbit. We, of course, are not to "pull" 100 tons, but we are undertaking to deliver 18-22.

[Babenkov] And what equipment will be included in these tons?

[Petrenko] First, it is proposed to install on the platforms equipment that is capable, in essence, of accomplishing a revolution in establishing telephone communication in the country. It is a shame to admit, but today more than 100,000 villages and towns in Russia do not have telephone communications at all. In the majority of rayons there are at best 10 telephones per 100 residents. In the northern part of the country and in the southern part of Central Asia there are even fewer: one telephone per 1,000 residents. With the placement of the space system into operation the number of subscribers will increase by several tens of millions. This means that nearly one resident in five will be able to have a telephone. Moreover, stable telephone communications will be established with 28,000 mobile subscribers. And not such communications as now—with an operating radius of the station of 25 km—while on a train, an airplane, and in a car it will be possible to get through to any subscriber in the world.

[Babenkov] Perhaps, is this—28,000 subscribers—a few?

[Petrenko] It is necessary to begin somewhere. And we hope that by the time of the launch of all three necessary platforms our communications workers will have developed more powerful stations. But telephones are far from the last "gift" of space. On the territory of nearly the entire country the stable reception of television programs and video information will be ensured. The opportunity to gather data from more than 100,000 measuring stations and buoys on catastrophic processes will appear. In short, new prospects will be afforded in informatization.

[Babenkov] And what must be done so that your words would become a reality?

[Petrenko] First of all to develop a rocket that is capable of lifting an 10-ton structure to a geostationary orbit. But as far as the dates, I am afraid that no one knows them specifically. We are directing our attention to 1993-1997.

The point is that the crisis also did not pass us over. We have been deprived of great certainty in the future. Imagine, soon a half a year will already have passed. True, they are "reassuring" us that we can, they say, count on last year's amount. But this is crumbs. The real purchasing power of this money decreased on three occasions. Especially as everyone is now trying to jack prices up a little more. Our sector, which has for the present parity with world space science, can give a large recoil.

Yes, we have many users of information, but do not have clients, who are willing to pay for the development and launch of the rocket. Whereas previously in case of centralized sources we did not feel this, now given the new economic relations it is as if a nerve has been exposed. Do not believe it: The most colossal program, about which I spoke, is not subsidized by the state.

## Space Program One of Five Priority Areas for Defense Industry Conversion

*LD0608173391 Moscow TASS in English 1436 GMT 6 Aug 91*

[By Yuriy Sizov]

[Text] Moscow August 6 (TASS)—"Without implementing the state programme for the defence industry conversion, economic restructuring in the USSR is unreal," First Deputy Prime Minister of the USSR Vladimir Shcherbakov told TASS.

He said that budget allocations for purchasing arms and military equipment were slashed by 9.5 billion rubles in 1991 as against 1988 to total 23.9 billion rubles (in prices of 1990).

The output of aircraft decreased 1.8 times in 1991 as against 1988; tanks—2.1 times; strategic missiles—2.4 times; ammunition—2.8 times; self-propelled and towed artillery—2.9 times; infantry combat vehicles, amphibious vehicles, and personnel armoured carriers—4.2 times.

According to Shcherbakov, arms production conversion covers upwards of 600 industrial plants in the defence sector, including 460 in the Russian Federation, 94 in the Ukrainian SSR [Soviet Socialist Republic], 19 in the Belorussian SSR, and 11 in the Kazakh SSR.

The USSR Ministry of Aircraft Building has the largest number of enterprises retooled for civilian work—118; the USSR Ministry of the Defence Industry—115; the

USSR Ministry of the Radio Equipment Production Industry—103; and the USSR Ministry of the Shipbuilding Industry—91.

The state programme for the defence industry conversion and the development of the production of civilian output in the defence sector for the period ending in 1995 comprises five priority programmes on the Union level.

One of them—a programme to develop civil aircraft in 1991-1995—features 7,990 million rubles in appropriations for research and development and envisages the supply of 22 billion rubles worth of civil aircraft and helicopters over this period.

Under the programme, it is planned to complete the trials and begin operating highly efficient IL-96-300, TU-204 and IL-114 aircraft of the new generation. The programme also envisages building and supplying, beginning from 1993 the new AN-38 aircraft to fly on domestic air lines.

A programme to develop the shipbuilding industry for civilian needs stipulates an increase by 1.75 times in the production of ships in 1995 as against 1991. The export of commercial ships is planned to be boosted by over two billion rubles in 1991-1995. The implementation of the programme will require 700 million rubles in capital investments.

The implementation of a space programme will need 11 billion rubles for research and development in 1991-1995, 700 million rubles in capital investments and 135 million in hard currency to purchase accessories, advanced technologies and computers.

A programme to develop communications systems for the national economy and in the interests of international cooperation will call for 4.35 billion rubles in capital investments to retool enterprises and organisations in this industry in 1991-1995, 4.6 billion rubles for research and development, including some 2,000 million rubles under contracts with customers, and the supply of over 16 billion rubles worth of equipment for communications facilities.

A programme of the USSR Ministry of the Nuclear Power Engineering Industry for the production of promising materials envisages an increase in the production of precious, rare, and rare-earth metals and high-tech chemical and metallurgical industry products up to 3.5 billion rubles; of extra-pure materials—up to 5.9 billion rubles; and fibre-optical equipment—up to 700 million rubles.

The indicators for the production of civilian output envisaged by the conversion programme are presented as forecasts for utilising capacities released as a result of arms production conversion by their retooling and development, Shcherbakov explained.

The key point of the programme is an increase in the manufacture of non-food consumer goods, which grew 1.8 times over five years. It is planned to boost the production of TV sets to 15 million in 1995, including colour TV sets—12 million; videotape recorders—2.4 million; tape recorders—7.5 million; refrigerators and freezers—8.7 million.

Conversion will create conditions for a drastic increase in the production of advanced medical equipment. Its output is planned to be increased two and a half times.

At the same time, many defense industry enterprises found themselves in a serious financial position as a result of the sharp decrease in military spending. In addition, the defense sector encountered the problem of losing its production and scientific potential.

A survey conducted by the USSR State Committee for Statistics shows that 228,000 (76 percent) out of 300,000 people who lost their jobs as a result of conversion in 1990 regained jobs at the same enterprises producing civilian output. Conversion is expected to force about 380,000 people out of work in 1991. Some 70,000 people will swell the ranks of unemployed.

As research and development for military purposes shrank in 1990-1991, the country has witnessed an outflow of scientific personnel from the defence sector. Some 40,000 employees at defence sector scientific research institutes and design bureaus quit their jobs in 1990. More than 90,000 people are expected to leave their jobs this year. Upwards of 300 defense industry scientific research institutes and design bureaus need financial support from the state to preserve their work remuneration funds in 1991.

Shcherbakov named the social protection of the working people as conversion is being implemented and its legal support as the number one problem being tackled by the USSR Cabinet of Ministers.

## Company Formed to Utilize Surplus Missiles for Commercial Launches

*PM2907091191 Moscow IZVESTIYA in Russian 25 Jul 91 Union Edition p 2*

[POSTFAKTUM report: "Military-Industrial Complex Representatives Set Up Joint-Stock Company"]

[Text] A constituent conference of the "Ural-Kosmos" closed joint-stock company [aktsionernoye obshchestvo zakrytogo tipa] has opened in Miass (Chelyabinsk Oblast). Most of the company's founders are representatives of the military-industrial complex. They intend to set up a company, and one of its main tasks will be to utilize for commercial purposes missiles which are coming to the end of their military life or are due to be destroyed under arms cuts. Their warheads will be replaced by communications satellites. The founders of the "Ural-Kosmos" company note that rockets will be launched both from land-based pads and from military submarines.

## NPO Energiya's Production of Medical Prostheses

*917Q0080 Moscow PRAVDA in Russian 20 Feb 91 pp 1, 3*

[Interview with NPO Energiya General Designer Yuriy Pavlovich Semenov, corresponding member of the USSR Academy of Sciences, recipient of the Lenin and State prizes and Hero of Socialist Labor, by PRAVDA special correspondent V. Panov, member of the presidium of the Central Board of the RSFSR Society for Disabled Persons, under the rubric "Yesterday, Today and Tomorrow": "How a Space Robot Can Become a 'Donor' for People"; ]

[Text] *...One would not think that space technology and prosthesis would have anything in common. But they really do have a lot in common. First, there are the materials: lightweight, durable, non-corroding metals and alloys, and modern non-toxic plastics and carbon plastics. Second, there are the numerous mechanisms in space vehicles and robots that perform essentially the same tasks as prostheses, which are called upon to make up for a person's deficiency or loss of motor functions.*

[Boxed item, page 1: NPO Energiya, 141070 Moscow Oblast, Kaliningrad, Ulitsa Lenina 4A, Telephone 516-42-42]

**Automatic space devices have long simulated successfully not just purely mechanical human motor functions, but also elements of thinking: the collection of information from the space around them, the analysis of the information, and the issuing of commands to actuators. (All that came together in Buran's unmanned flight.) But, indeed, that is precisely what tomorrow holds for prosthesis that involves not just the extremities, but also the organs of sight and hearing.**

**That's why the decree of the USSR government transferring the business of prosthesis via the conversion program to the jurisdiction of the USSR Ministry of General Machine Building is entirely logical. More specifically, it was transferred to NPO Energiya, the design collective that was established by the chief designer of rocket-space systems, Academician S.P. Korolev, and headed by him until the day he died.**

**Today, we present to our readers a conversation between NPO Energiya General Designer Yu. P. Semenov, corresponding member of the USSR Academy of Sciences, recipient of the Lenin and State prizes and Hero of Socialist Labor, and our special correspondent, V. Panov, member of the presidium of the Central Board of the RSFSR Society for Disabled Persons.**

**Panov:** Yuriy Pavlovich, in the first year of work in prosthesis, NPO Energiya's experimental production unit manufactured 3,000 sets of assemblies and parts equal in quality to the best foreign models and released them for use in the replacement of limbs of soldiers injured in the performance of their internationalist duties.

What else would you comment on with respect to the business of prosthesis that was assigned to you?

**Semenov:** We were notified in advance that NPO Energiya would be assigned work in the field of prosthesis. But only a few people were able to conceive the full gravity of the situation. Additionally, we were given the responsibility for implementation of the scientific-technical policies in prosthesis. We were clearly not prepared for that turn of events.

In the year since the USSR government decree was issued, we have managed to set up series production of prosthetic assemblies at our experimental plant, and those assemblies are, in fact, on a par with foreign models in many parameters. In the past year alone, we have manufactured 20,000 sets of prostheses for the lower extremities. Test stand facilities have been created for perfecting the prostheses in terms of durability and useful life. Headed by NPO Energiya, a cooperative system has been set up that has made it possible to create designs that meet the latest requirements for typical prosthetic-orthopedic enterprises, repair shops and workshops, including mobile ones. This year has seen the start up of production of customized equipment for the country's prosthetic-orthopedic enterprises that have been established on the basis of our own experience and foreign experience.

An experimental center for prosthesis and personnel training has been established as part of NPO Energiya, and disabled testers themselves will check the new assemblies and modules at the center. In essence, the center will become the proving ground for new prosthetic equipment.

The recently established Council of Chief Designers has been called upon to coordinate all the work throughout the country on prosthesis-fitting and prosthesis-making, to shape the technical policies within the sector, and to monitor their implementation. However, it should not be forgotten that any new work raises a lot of new questions and problems. But we are looking toward the future with optimism.

**Panov:** What do you see as the reasons for the sorry state of affairs in our domestic prosthesis-fitting and prosthesis-making? I have in mind the engineering aspect.

**Semenov:** At one point, the answer to that question was sought by a special group of the most experienced and self-starting specialists of the head design bureau, under the leadership of my first deputy, Professor V. P. Legostayev, who is a doctor of technical sciences and a scientist of world renown in the field of precision mechanics. He is also now supervising the work on the conversion of our production line to handle prosthesis production.

The sources of the problems are in the low level of financing and the lack of attention to the sector's needs, which has been true for decades, plus the far-from-optimal organization of the work on a union-wide scale. As a result, the "sores" grew into a serious illness whose cure would require large amounts of material resources and years of strenuous work. But, in and of itself, successful prosthesis still does not solve the problem of putting a person back in working order. Also necessary is an efficiently tuned process of social, psychological and work rehabilitation. I would not begin to try to judge the problems of preparing a patient for wearing a prosthesis—that is a matter for the doctors. I will, however, say a few words with respect to other problems.

In my opinion, the solution to the problems lies in the establishment across the country of a network of well-equipped rehabilitation centers where people, after receiving a prosthesis, would be able to re-adapt to their previous profession or learn a new one. We have practically no such medical or technical facilities in our country today. Moreover, a number of measures must be incorporated in transportation and in stores. A lot also depends on the architects and planners. Specially designed apartments are needed for disabled persons, as well as specially designed plumbing fixtures. We have heard all this repeatedly, but there have been no real movements in that direction. The production of a whole assortment of everyday articles needs to be developed and in place. All of it will be repaid with interest, because people who must now care for disabled persons will be returned to the sphere of material production, and even the disabled themselves will be able to engage in socially useful labor. I hope that the Law on Disabled Persons recently adopted by the USSR Supreme Soviet will finally set all this into motion.

By the way, not a single VUZ (higher educational institution) in the country is turning out either engineers or prosthetists. The situation in this matter is critical. It is not just a matter of skills. There are no more than 500 master prosthetists in the country. And yet, based on international standards, we need no fewer than 3,000. But the problem is still in the discussion stage.

**Panov:** Having 40 years of experience in daily "contact" with a prosthesis and 20 years of experience in making my own prosthesis, I proposed the production of a calf prosthesis of my own design, and the USSR State Committee for Inventions and Discoveries issued me a patent for it. The design, created at home, has served me flawlessly for 15 years instead of the 0.8 year that is the average period of serviceability of a prosthesis made by the state.

In your opinion, what measures are needed to bring our domestic prosthesis industry from the level of a "wooden leg" to the forefront of contemporary scientific-technical progress? And what is most important—to solve a basic contradiction in this sphere: the mass production of custom items?

**Semenov:** There are skilled prosthesis makers in the country, who are in no way inferior to foreign makers. This can be judged by the level of developmental work done in the Russian and Ukrainian institutes.

Now we are geared up for the priority introduction of those developments in order to meet the needs of most of the country's disabled persons more quickly. Moreover, already accepted for production is a prosthetic hand made by G. Rudenko, an amateur craftsman like yourself, who lost his own hands in the Great Patriotic War. The unique experience of the combining the consumer and the manufacturer in the same person is extraordinarily important for us. This is why we have included both of you as members of the scientific-technical council of NPO Energiya's chief designers.

Now, about the equipping of the prosthetic-orthopedic enterprises. Work here has been started in two directions: first, the provision of nonstandard equipment and the development of new manufacturing processes and, second, the development and introduction of equipment and stands that will make it possible for the prosthetist to specify in each specific instance precisely the type of prosthesis needed and to check its quality. We must see to it that those enterprises are supplied with materials in the proper packing.

**Panov:** Twice already, a team of legless runners from the American Achilles Athletic Club has participated in the Moscow International World Marathon. The best times by the those running on prostheses were 11.6 seconds in the 100-meter run and three hours 15-20 minutes in the marathon (42 km 195 m). Not every young, perfectly healthy person with real arms and legs, including even a modern-day cosmonaut, is capable of matching that.

**Semenov:** In general, I agree with the way you put the question. But let us not get ahead of events just yet.

Our enterprise has manufactured the first models of athletic prostheses, and they are undergoing bench tests. But the matter of breaking records in a marathon run will be decided by the disabled persons themselves and their trainers.

**Panov:** In the 1960s, after graduating from the Moscow Higher Technical School imeni N.E. Bauman, I worked in this building as an engineer of the design bureau headed by S.P. Korolev. It is not from newspaper articles that I know of Sergey Pavlovich's conviction that everyone should be able to fly into space, including people with functional disorders of the body. Why do we not go even further today: form a group of fellows—"Afghans," for example, with amputated lower legs—to train for a flight into space? Especially since there have been similar precedents: for example, A.P. Maresyev, the fighter pilot and Hero of the Soviet Union.

**Semenov:** That matter has already been discussed. Personally, I share your view and support your proposal. It would help lift the spirit of millions of people considerably. But you must agree: the medical, psychological and

other "filters" in the selection of cosmonauts are much "denser" than those that were used for the Air Force's fighter pilots. Nevertheless, analyses of medical data sent back from spacecraft and stations have recorded quite a few deviations from the norm in the health of crew members. There also exist well-established deviations in their physiology. How will all that affect people with locomotor disorders? That's why, before deciding finally about the matter of a flight by an amputee into space, we need to ask the doctors to conduct special research.

**Conclusion**

"On Measures for Further Improvement..." One may think that things were fine, and they will become even better. I seem to remember a multitude of decrees of varying "caliber" with similar wording in the title—but no apparent improvements followed. Will that happen this time?

The matter has been taken up by the representatives of a unique school of engineering and design thought. This is why there is every reason to believe that our domestic prosthesis-fitting and prosthesis-making have begun a new era in their history.

**Photo Caption**

1. Tester T. Kuznetsova from Chelyabinsk is the country's first and, as yet, only person to cover, on a prosthesis, the entire marathon distance of 42 km 195 m. Tanya has been a participant in two Moscow World Marathons and the New York City Marathon. [Photo not reproduced]

## Successes of NPO Energiya in Conversion Program Lauded

*917Q0077 Moscow IZVESTIYA in Russian 4 Apr 91 p 3*

[Article by Ye. Konovalov, IZVESTIYA science commentator: "Domestic Companions of Rockets: Why There Will Be No Mass Firings at the Firm Where Gagarin's Spacecraft Was Developed"]

[Text] At first glance, the enterprise's situation right now seems absolutely tragic. The budget allocations have been reduced to the point that it will be necessary to fire several thousand people. Is the flower of rocket technology to be thrown out into the street? Is the creative collective that has glorified our homeland like perhaps no other, to be destroyed? That, of course, would be a crime for which there would be no justification.

And, to be honest, when I rode into suburban Moscow's Kaliningrad, which old-timers near the railroad station still refer to by the old and pretty Russian name Podlipki, I had expected to hear the song which has become so common in our time: "we fell under conversion," "There is no money," "We are destroying the defense complex," "Treason..."

But I heard nothing of the sort, rather, I encountered energetic people who are dealing enthusiastically with the problem of the restructuring rocket-space production. The whole idea is a simple one: to develop a strong national-economy-oriented industry, while still preserving the basic space-related potential.

That point was most graphically evident in the gigantic old assembly shop, which is probably as tall as a 10-story building. Along one of its walls, they have lined up rockets, in an upright position, ranging from the very first R-1 to the R-7—that famous No. 7, a modification of which put the first satellite, and Gagarin, into space. Approximately a third of the premises was enclosed in a glass partition, behind which Buran soared, as it were. Here they are assembling and testing a docking module that will enable Buran to operate in concert with the Mir orbital station. But all the rest of the enormous space was filled with dough mixers. Glistening with stainless steel, ennobled by an excellent design, they were like imported mixers, but they had been made here—in the experimental machine building plant that is part of the NPO [Scientific Production Association] Energiya, as Korolev's firm is now called.

I once saw a cartoon about rocket technology in which a long loaf of bread, instead of a rocket, is flying up out of a service tower flung wide-open—as if to say, that is why we have no bread. The person who drew the cartoon should be brought to this room to see the "rocket machines" that are used for preparing the dough from which long loaves are baked. Each of those automatic units can produce 1,300 kg of dough per hour for bakeries.

Numerous complaints have been made about wastefulness surrounding the Energiya-Buran system. And yet, for use in the national economy, the NPO is ready to transfer some 600 processes and materials developed for that system! And it is not the fault of the rocket scientists, rather it is to their distress, that those processes are still not being used properly. NPO Energiya is doing everything it can.

In the shop where they manufacture the fuel tanks for space hardware, I saw pressure-chamber systems that are used for treatment and for surgical procedures that are performed in a special atmosphere for adults and children. In essence, they are ground-based spacecraft with their own life-support systems, special control systems, and airlocks.

Right next to it, in the adjacent bay, they are building a unique 22-meter-long ocean-going yacht. It has been "riveted" together from sheets of a non-corroding aluminum alloy. Until now, such yachts had been made only from wood and plastics. The first riveted yacht is scheduled to participate in the famous America's Cup Race in 1992. If space technology successfully passes that test, then there will be a large market for such yachts, which cost more than a million dollars apiece.

The current general designer of NPO Energiya, Yu. P. Semenov, a corresponding member of the USSR Academy of Sciences, made it obligatory for all the scientific design and production subdivisions to participate in the enterprise's conversion. Professor V. P. Legostayev, the first deputy general designer, was appointed specifically to rigorously pursue the solution of conversion problems. And they are pursuing a consistent policy for the integral consolidation of the NPO's primary areas of work and conversion. That is being done by the very same people, frequently in the very same workplaces.

Under the supervision of Doctor of Technical Sciences B. A. Sokolov, work was being performed on Buran's engines. And also under his supervision, the engine shop had developed and had begun to series-produce turbo-vacuum compressors for transporting friable cargoes, aerating various products—flour, peas and grain bulk-stored in bins—and packing candies into boxes.

Inasmuch as they have made excellent turbopump assemblies for Buran's engines, they were able to develop machines better than similar models from the West German firm of Siemens—a world leader in that field of machine building.

In the development of conversion products, use is made of the same methods, materials and testing techniques that are used for the NPO's main products, which are as yet on a state-of-the-art, world-class level. And that is producing splendid results. When NPO Energiya undertook the development of prostheses, which were at a "primitive level" in our country, the world's best firms in that field were skeptical: in about 10 or 15 years, you may catch up to us. Now they are holding talks about establishing joint ventures. Korolev's firm needed only a year to reach the highest world-class level of prosthesis-making. And that was to get industrial production going, not just produce some experimental models.

The irony is that, at the moment, our poverty-stricken social agencies do not have the money to purchase the prostheses for the disabled. Also having are hard time are the orthopedic shops, which have now begun to receive modular feet, ankles, joints and so on for individual fitting. In our vast country, there are only 128 such shops, while there are 600 of them in Germany. The problem must be solved by the health care and social security system.

But the rocket scientists will not let us down. On the test stands, some artificial legs have already been "trudging along" for three-four years. Lightweight prostheses are being developed for children and women, along with orthopedic prostheses which replace individual joints. I was shown old orthopedic prostheses weighing 16 kg and new ones made of titanium and carbon-plastic, which were no heavier than 1.5 kg. Already this year, 45,000 various prostheses, including orthopedic ones, will be produced.

The first prosthesis was assembled in the shop where, at one time, the world's first artificial satellites were assembled. And today in NPO Energiya, they are placing on the prostheses their own logo, with a stylized image of the first satellite. And they take no less pride in the prostheses than they did in the satellites.

I have had occasion more than once to write about flights of cosmonauts from other countries that were performed aboard our craft in the name of an unselfish strengthening of friendship and cooperation, but now turn out to have been, as it is customary to say in Russia, thrown to the wrong end of the dog [they were for naught]. But now I will try to give you some idea of what, approximately, we will soon receive for the money which is now being paid to our country for the commercial flights of foreign cosmonauts.

The Japanese firm Sanyo will supply NPO Energiya with equipment for producing food processors and vacuum cleaners. The first steamships have already left Japan with assembly lines that a new, two-story modular building, with a total area of 6,500 square meter, is ready to receive. Construction work is in full swing in a former foundry, which is also intended now for Japanese machine tool equipment.

"Here," points out I. B. Khazanov, the plant's chief engineer, "we used to have old-fashioned cupolas for casting pigiron, and it was the most ecologically filthy production in the city. We simply could not bring ourselves to change over to electric furnaces. We were afraid to stop. And now necessity has forced us....People were told that no one would lose any wages, we would not fire anyone, and now we are refitting the premises, and by the end of the year, we will be working with the Japanese equipment and producing consumer goods."

Some of the bays of the blackened, ancient foundry have already been transformed, cement is being poured on the floor in others, and the walls are being lined with ceramic tiles. The work is proceeding apace.

I saw the food processors which will be produced. What fun they will be! A housewife's dream. They can perform 32 different functions. Vacuum cleaners can also be produced with the equipment that is used to produce the processors. In all, the equipment will be able to produce around 600,000 machines per year.

Now it is even comical to recall the battles that raged: a Japanese journalist could be the first one launched into space, in exchange for money, or a Soviet journalist could go free of charge, but for the sake of prestige in our impoverished country. Ask a housewife who is dying to buy a food processor which one she prefers.

I foresee a chorus of objections: yachts, food processors, pressure cookers and vacuum cleaners—this is fine, but what about the country's rocket might? It will not suffer. Without curtailing its primary production, NPO Energiya (if you consider all the areas producing in conversion products) has also been able to start up an

additional plant with an area of 34,000 square meters for the production of consumer goods. With our usual pace, it would take about 10-15 years to construct one at a new site. And what about personnel—where are we supposed to get new people? We would have to build housing for them, stores, schools, kindergartens, polyclinics.

But this way the problem is being solved without any detriment to the normal course of business. An the main thing is that the NPO will make up what it didn't get in budget allocations through the mass production of consumer goods, and it will obtain the 50-60 million [rubles] per year so needed by it to maintain and develop Kalingrad's social infrastructure.

I will not write in detail about the NPO's primary mission—that would be far too vast a task—but I will address the main thing which newspaper criticism has touched upon. Now they have already begun to figure how much will be spent, and how much can be received. But the most important thing, perhaps, is the fact that they have begun to pay an enormous amount of attention to equipment needed by all people.

"It is no secret to anyone in our sector," says Yu. Semenov, "that the Energiya-Buran system was ordered from us by the military. It was said at meetings on various levels that the American Shuttles, even on the first orbital revolution, could perform a lateral maneuver and turn out to be over Moscow, possibly with a dangerous cargo. Parity is needed—we need the same type of rocket-space system. We made a better one than the Americans did. But the former customers are now abandoning it—outlays for defense are being curtailed. Well then, is this very useful system supposed to be thrown into the trash can? No, it simply needs to be reoriented to national-economic areas. We're faced with a very pressing problem that can be quickly solved with the Energiya rocket, which can operate alone or in conjunction with Buran. That problem consists in organizing communications within the country."

Indeed, each of us knows what a deplorable state our communications are in. NPO Energiya is proposing to insert into geostationary orbit three large, general-purpose platforms weighing of around 18 tons. Their complex "stuffing" will enable the use of rather simple ground systems to meet the country's needs for multi-program television broadcasting throughout the country and for nationwide communications channels and to provide universal telephone service, including in rural areas (which are now practically devoid of telephones), and communications with mobile facilities—ships, aircraft, trains and motor vehicles.

The traditional methods for doing those things would require at least 70 billion rubles [R]. The simpler communications satellites would require too large a number of them. The estimates of the specialists from the recently established Energiya-Marafon [Energy-Marathon] Association, which more than 50 enterprises have already joined, indicate that they will need, in all, R13 billion to handle the tasks.

It is not a journalist's job to compare and analyze the various methods for handling the tasks. I can only testify that the Energiya-Marafon Association is so sure of the direction it is taking that it is not requesting budget allocations, but rather, only credit. This year, they have already borrowed on credit R540 million. In 1994, they intend to begin operating the system, and preliminary estimates indicate that they can derive a profit of at least R14 billion over the predicted 10 years of the system's operation. We must emphasize that this is the first domestic space project to be effected on credit and the derivation of profits from future services. Commerce has finally come to our space program.

But what is happening now in NPO Energiya can't really be called conversion—rather, it is more like what the rest of the world calls diversification. (To put it simply, a single-line industry becomes a multi-line industry and can maintain the existence of one of its sectors with the profits from another.) And that's a common phenomenon for any large firm in a market economy. It is rare for any such firm to be supported by a single "whale"—rather, it is preferable to have two or three, or even more, so as to always remain afloat. And quite opportunely now, germinating in the interior of NPO Energiya is an area that, in time, could become no less important for it than space is now.

In the World Ocean, there are sections of the bottom that are strewn with so-called nodules—little lumps saturated with manganese, cobalt, nickel, copper and other valuable substances. In the most promising area of Clarion-Clipperton, the USSR has been allocated a section of the bottom of the Pacific Ocean roughly the size of Hungary for the mining of those nodules. The Ministry of Geology has long been seeking efficient means of mining them and has turned to NPO Energiya for assistance.

And now, here at the NPO, a system is being developed which will make it possible to use special remote-controlled, unmanned cars to gather the nodules and bring them to an "elevator" and, with a cable system, raise them up to the ocean-going ships from a depth of six kilometers.

"Unlike the method previously considered promising—that of sucking the nodules up from the bottom through a tube," says Doctor of Technical Sciences L. A. Gorshkov, "our method is ecologically clean. The productivity is also rather high, and the development of the system will require the efforts of virtually all our subdivisions, including even the Flight Control Center."

You see the range of operations—from the deepest depression on the bottom of the ocean to lunar and Mars projects. All of it can be done by the collective which, 30 years ago, developed the Vostok spacecraft for the flight of the first man into space.

## Military-Industrial Exchange Formed at Flight Control Center

*LD0407103191 Moscow TASS International Service in Russian 1810 GMT 3 Jul 91*

[By TASS correspondent Rena Kuznetsova]

[Text] Moscow 3 Jul (TASS)—A military-industrial exchange has been established in the Soviet Union. Journalists were told of this today at a news conference at the Space Flight Control Center.

One of the main tasks of the exchange is to defend, in market conditions, the military-industrial complex, which together with other enterprises in the Soviet Union is to emerge into the new wholesale market. Viktor Surikov, a member of the exchange council, reported that all the deals carried out at the exchange will be insured. An insurance company is to be an integral part of the exchange operation.

The main headquarters of the exchange will be in the Space Flight Control Center. The Russian goods and raw materials exchange, and the Central Scientific Research Institute for Machine Building are the organizers of the exchange.

Sergey Petrov, the main organizer of the exchange, addressed journalists. He reported that today, the founding capital of the exchange is R 30 million and the cost of one share is R 300,000.

## Flight Control Center's Relation to Military-Industrial Exchange Viewed

*PM1007101391 Moscow Central Television Vostok Program and Orbita Networks in Russian 1530 GMT 4 Jul 91*

[From the "Vremya" newscast: Report by A. Gerasimov and N. Glebov, identified by caption]

[Text] [Gerasimov] The whole world knows the Moscow Flight Control Center. But only a few people know that nowadays only an insignificant part of the huge potential that was initially invested in the Flight Control Center when it was created is being used. Suffice it to say that, if there were five or six manned craft in space at the same time, the Flight Control Center could cope with ease. But this is not what is happening.

Nowadays there is not enough money, and not only for spacecraft—at times there is not enough money to pay employees' salaries. This situation exists at virtually all enterprises of the military-industrial complex. But, as the saying goes:

[Gerasimov, speaking to camera] Every cloud has a silver lining. The cutbacks which have reduced the budget of the Soviet military-industrial complex beyond recognition have evoked a reaction at enterprises of the defense industry. They have formed a joint-stock company with the unusual name "Military-Industrial Exchange".

The founder members are the Russian Commodity Exchange and a leading space company, the Institute of Machine Building. The hall of the Flight Control Center and its computer center and numerous communications facilities which are standing idle will be used for conducting trade deals.

This is the most successful kind of conversion, one of the founders of the exchange, Doctor of Technical Sciences Viktor Surikov, has stated. In fact, only enterprises which have so-called "special departments" [pervyy otdel] can be shareholders.

After all, the articles on offer will include goods and technologies still classified as secret. But in principle anybody, including even foreigners, can place orders at the exchange.

## IZVESTIYA Commentary on Military-Industrial Exchange at Flight Control Center

*PM1007135391 Moscow IZVESTIYA in Russian 5 Jul 91 Union Edition p 2*

[Report by B. Konovalov: "Cosmonautics' Second Profession. Military-Industrial Exchange Set Up At Flight Control Center"]

[Text] The future market is changing many established notions. The Flight Control Center in Kaliningrad, Moscow Oblast, has always been a venue for secret communications with cosmonauts, interplanetary stations, and automatic satellites. Now what you might call an entirely alien structure—a defense industry sectors' exchange—has been set up there.

It is situated in the new building that was especially constructed for the start of the "Buran" Soviet space shuttle flights. The building is rich in marble and is crammed with the most modern information hardware, but it has so far operated with only one Buran spacecraft, which made a three-hour flight around the planet. Things are no better with the other vehicles the building was constructed to control—it can handle seven objects in space at one time. Soviet cosmonautics is currently faced with a real threat rather than a specter of unemployment and a painful cut in the staff of highly skilled specialists, who only recently were considered the pride of the Soviet Union.

"In these conditions," Professor V.M. Surikov, first deputy director of the Central Scientific Research Institute of Machine Building, of which the Flight Control Center is part, told journalists, "we have decided to actively prepare for a market setup. The lease payment for premises for the exchange alone would constitute a substantial part of the institute's budget. Moreover, it means hundreds of highly paid jobs for our specialists,

who have vast experience of swift processing of enormous volumes of information, the hardware for the job, and reliable communications. It is a natural and very rational conversion route for the Flight Control Center, which has one of the most powerful information and communications system in the USSR today."

Exchanges have lost their novelty value—we already have more than 100 in the country—but a military-industrial exchange will be special, with a secret department which will collect information on enterprises coming under the heading of state secrets, which they are not allowed to give to conventional exchanges. Private deals concerning weapons could also be struck. Only defense industry enterprises can be exchange shareholders. Incidentally, the first batch of shares, each costing 300,000 rubles [R] is already sold out. But the auctions will be open to all enterprises, although they will be more computerized than at conventional exchanges.

Defense enterprises are scattered all over the country, so you might think they might encounter problems communicating with their exchange. But here too a solution has been found. There are several dozen departmental communication systems, private and open, in the USSR, planned to handle peak loads. But such loads occur extremely rarely, so the reserve capacities can be leased out. A "Space Communications" joint-stock company has already been organized for this purpose.

"Our organization was set up on the initiative of the Russian Commodity and Raw Material Exchange and the Central Scientific Research Institute of Machine Building," we were told by S.P. Petrov, chief manager of the Military-Industrial Exchange. (He is already well-known in the country's exchanges—cochairman of the Russian Commodity and Raw Material Exchange and vice president of the country's Exchanges Congress). "A specialized insurance company and a network of banks for credits are currently being organized. Credit and insurance will be provided for all deals on the basis of open and private information on enterprises. Moreover, the exchange will be able to organize the competitive allocation of military orders."

Note also that the new exchange will not only be a communication center for all defense enterprises, but will link up all the exchanges in the country. In the future, communications will be set up with world exchanges. The Exchanges Congress headquarters is being organized in Kaliningrad, Moscow Oblast.

...As we were leaving the press conference, a plan of the Military-Industrial Exchange appeared on the central screen in the "Buran" control room. On the two side screens there were spacecraft. No one knows as yet when "Buran" is going to start regular flights, but the exchange is already operating.

## Journalist's Account of 1989 Visit to Baykonur

*917Q0094 Kiev PRAVDA UKRAINY in Russian 12 Apr 91 p 3*

[Article by Viktor Nikipelov, under the rubric "Today Is Space Program Day: A Report That Didn't Get Written in 1989": "Baykonur Without Secrets: The Impressions of a Man Who Visited Cosmodrome Facilities That Not Long Ago Were Superinaccessible"]

[Text] Surprising things often happen to journalists: one minute, ineffable luck is suddenly smiling on them, and the information is flowing, as they say, "on wheels"; the next minute, something unforeseen instantly turns all their well-ordered plans upside down, and the first line of a future newspaper article never gets written.

Such a thing, I confess, also happened to me, in early September 1989, after a most fascinating temporary assignment to Baykonur that had come like a bolt out of the blue. My colleagues and I at the time managed to go where outsiders had literally never set foot. And, of course, after having penetrated the inner sanctum of the domestic space program, I heard and saw for the first time our chief creators of space hardware, and after having run my hands over Buran and having made the acquaintance of the rank-and-file inhabitants of Leninsk—that seemingly provincial military town known to the entire world as Baykonur, a name shrouded in mystery—I, of course, wanted to go back home and tell our readers all the details about the legendary cosmodrome and about its people.

A simple formality remained: find out whether everything I saw could be, well, written about. After all, it involved state-of-the-art things that were heavily guarded from the entire world under lock and key. People who were supposed to know answered me at that time quite unequivocally: "You heard and saw here exactly as much as was intended for representatives of the press to find out. You don't need to get anything stamped. After all, besides you, there were several dozen representatives of large mass media organizations from various countries here—they took pictures and made video tapes and recorded with dictaphones."

And still, knowing some of our procedures, when I returned to Kiev, I dropped in to see the editors of the Main Administration for Safeguarding State Secrets in the Press and clarified some things. After which, I came to understand that if my materials weren't first stamped in Moscow by various organizations, my impressions would hardly be able to see the light of day without being abridged substantially. And therefore, vexed, I put the notebooks with notes and the recording tapes away. Forever, I thought.

But the times, it seems, are changing, and today I can report in detail to the readers about everything that I saw back then, without submitting anything for anyone's approval and without getting anything stamped. It's a

blessing, and the occasion is most apt—the 30th anniversary of the first manned space flight. Moreover, I had also had occasion to take a stroll over the plates of that launch complex—Gagarin's.

**Temporary Assignment**

Everything began with a surprise call to the editorial office from the press center of the USSR Ministry of Foreign Affairs: from the Ukraine—as from each union republic—one journalist was being invited for the first time to the launch of a manned spacecraft, the next morning he should be at our place, on Zubovskiy Boulevard. Among the candidates for the assignment, I was a backup, just as with the cosmonauts. But it turns out that a backup can be lucky sometimes, and I found myself flying to Baykonur!

We took off in the Il-76 military transport aircraft as a pretty large "team"—more than 120 people. They consisted of representatives of many large publications and television companies and our central press, All-Union Radio, and Central Television, as well as journalists representing republic-level mass media.

Just before we landed, we got our first surprise: we had taken off for Baykonur, but we were landing at the airfield of the city of Leninsk. It turns out that the name Baykonur is a longstanding myth. A point on the map with such a name actually exists, but it's located nearly 400 km away. And that, too, was officially told to journalists for the first time at a press conference that was held literally right after our arrival at the hotel. And that kind of strict rhythm of work was maintained during our entire stay at the cosmodrome. There everything was scheduled for everyone to the minute, and there we were encountered with a completely different life.

**'The Gagarin Launch'**

The next day reveille was at 0500. We had a quick breakfast, and four buses were already waiting for us. Each one had its own guide who was prepared for literally question we had.

"Can we take still cameras and television cameras with us?"

"Of course, otherwise why would you have come here?"

"Can we change buses?"

"Certainly. Just let me know beforehand, otherwise the entire column will not be able to move until we figure out where the 'shortfall' of people has gone."

Which, after all, was understandable—we weren't on an outing at GUM [State Department Store].

After a few hours on a very bumpy road, the buses pull up to the legendary Gagarin launch complex. Suddenly we stop near a railroad embankment that is parallel to our road, and on it, in the rays of the rising Sun, lying on an enormous railroad flatcar, is the mighty, silvery hull of a booster rocket, with the show-white Soyuz TM-8 spacecraft mated to it.

Oh, and all at once, the cameras began clicking, and the TV cameramen, with video cameras on their shoulders, began making a commotion to find just the right angle! And we—the writing brotherhood—simultaneously "attacked" the generals and the colonels with light-blue collar tabs on their uniforms, who had appeared next to us as if out of nowhere.

"This is *the* legendary launch pad from which Yuriy Gagarin lifted off," explained TASS correspondent Nikolay Kuzmich Zheleznov, who had "taken me under his wing." Zheleznov is one of the patriarchs of our space journalism. "I have already been here several times, although, of course, unofficially."

I stepped back a little and transported myself in my mind to that April morning in 1961. This is just how they transported the same kind of rocket, this is just how the technicians bustled anxiously, erecting the rocket at the launch complex, connecting the gantries to it, and hooking up the life-support lines.

And while all this was being done, the future Cosmonaut-1 slept serenely, as medical personnel testified, on a very simple bed in a small room of a modest little wood house. And nearby, in an adjacent building, Sergey Pavlovich Korolev, who was less calm during those hours, spent the night. After we left the complex, they took us, of course, to those same small memorial museums, where the entire essentially ascetic setting has remained as it was on the morning of 12 April 1961.

We have become accustomed already to regular launches of people into orbit, and we have largely lost our ability to see how courageous their efforts are. And, I confess, everything that took place, everything I saw, I perceived somehow as commonplace.

Commonplace until I felt at the observation post, which was two kilometers from the pad, how the steel began to rattle and the ground began to tremble under my feet during the launch of the Soyuz carrying A. S. Viktorenko and A. A. Serebrov, until the powerful air waves hit my chest. And it was as if a one-ton shroud of perception had fallen away, and everything suddenly acquired rich, contrasting colors. In just those few seconds, the rocket was transformed before my eyes from a rumbling enormous column of fire into an ever decreasing bright point, until it was no longer as big as nay of the stars that were also gleaming brightly in the dark Kazakhstan sky.

**Buran**

Have many people in our country had even one opportunity to look around inside the shuttle or to touch its "brontosaurus" surface? Understandably, no.

The first impression one gets is that it is nothing special. But when a youngish, smart-looking man in a gray suit

appeared under the jigs on which Buran was mounted, and dropping by the hanger with him was Lt. Gen. I. I. Kurinnyy, who, it had just been divulged to the journalists, was deputy chairman of the State Commission, I became interested.

"Petr Sergeyevich Bratsykhin, engineer," the "civilian" introduced himself to the journalists, "lead specialist for the Energiya-Buran system. I am ready to answer any of your questions."

And it began:

"How long is a Buran orbital mission designed to last?"

"Up to one month. The frequency of the missions may change, depending on the program or some other contingency."

"Who gave the craft the name Buran?"

"Its 'father.'"

"And how do these two Burans standing next to each other differ?"

"One of them is an engineering craft that consists of the same components as the regular orbital Buran—a ground model, so the speak. On it we can 'run' any unusual situation that, God forbid, could occur with the real Buran in orbit. So-called fitting tests are also run on it."

"And what are the differences between the Shuttle and Buran?" I asked I. I. Kurinnyy.

"The differences are substantial. Although some people say that we copied the Shuttle. But we took our own route, and if the work that was begun by Sergey Pavlovich Korolev had not been interrupted at one time, I think we would have had a space shuttle system even before the Americans.

"But if we talk specifics, the American reusable space system was designed for just one purpose—to put a reusable craft into orbit, whereas our Energiya launch vehicle can put any facility weighing up to 120 tons into space. The Americans, however, are capable at this point of putting only 20 tons into orbit." "Do we lead the United States in terms of the level of development of space hardware?"

"The Americans believe that we are ahead."

"But why do we need Buran at all?"

"First of all, so that we can fly into space and to return from there to Earth without ceremony. So that we can perform in-orbit repair and rescue operations."

"Igor Ivanovich, how many people in all can be aboard Buran at the same time during a mission?"

"The regular ship's bill provides for up to seven, but the emergency bill provides for up to 10."

"And can Buran itself put satellites into orbit?"

"We will be able to use it to put two or three satellites into orbit simultaneously, which is very profitable economically."

**Energiya**

Millions of people have seen our Energiya rocket, the most powerful rocket in the world, on television and in illustrations and photographs. In the assembly-and-testing building, several thousand people see it daily. But the republic internal security guards who sit at the entrance gates, let through only a handful of visitors on special passes every month. Today about 150 people passed them, and they were bewildered. And everything was without the presentation of any documents, and with still cameras and television cameras, to boot. Can you imagine the internal state of the security?

But another thing, I realize, disturbed me: Why did they let us into this kingdom of sterility without white lab coats? It turns out that it will take at least two days to purify the air inside the complex of the dust that was brought in by 150 people. Can you imagine?

And now imagine that some terribly intelligent individual, going crazy, as is usual in our country, with the next campaign—right now, it's conversion—had forced the specialists of this unique complex to produce, of all things, beds. Can you imagine? I certainly can't. And it was only after the appropriate remark on the program "Vremya" was this disgraceful thing halted.

It is understandable now with what affability the "boss" of this entire installation, Boris Ivanovich Gubanov—one of the successors of S. P. Korolev, the chief designer of Energiya, a doctor of technical sciences, a Lenin Prize laureate, and a Hero of Socialist Labor—greeted the journalists. He showed all the stages of the assembly of the giant rocket and told in detail about its virtues and about all the advantages that its extensive use promises.

If you're talking about, for example, learning of space or about man's future penetration into the universe, then Energiya can be used for the rapid and efficient establishment of a special base on the Moon in the future—a kind of trampoline for flights of manned spacecraft to Mars and to other planets. Today, one of the country's institutes is developing a giant telescope, 10 m in diameter, for studying the universe. It is understandable how much the possibilities of such a tool will increase if researchers "take a look" into space through it from space orbit. And such a bulky facility, just like high-tonnage platforms, can only be put into a reference orbit with the aid of Energiya.

And, of course, the chief designer, in satisfying the professional curiosity of the journalists, answered their numerous questions.

"How many Energiyas are they building?"

"The production capacity of this facility is five or six rockets a year, but under the pressure of this complement

here," Gubanov said, with the wave of his hand taking in our entire group, "we are producing just one."

"And is it difficult to produce such rockets?"

"We worked more than 10 years on this one together with the launch complexes and so forth."

And here I also succeeded in asking the designer my own question:

"If it is not a secret, how many people worked on the development of Energiya?"

"At one time—during the intensive work—at the entire complex, including the launch complex, there were as many as 14,000 people. But now, somewhere around 10,000 remain. But that is with all the servicing personnel."

"And the entire Energiya-Buran complex?"

"If you count everyone together in the entire chain, from the ore to the rocket, as they say, 1.2 million people at 1,200 enterprises and organizations. Practically the entire country made it."

The notebooks and recording tapes preserve other interesting information that open the door a little to some of Baykonur's secrets. But, as you know, there's only so much space in a newspaper.

It will seem to many people that, perhaps, on the day of the 30th anniversary of Yuriy Gagarin's flight into space, it is not becoming to talk about all this, and not to talk about Gagarin himself. But what I have related to you is a continuation of his cause. Therefore, it is also about him.

## Achievements of NPO Yuzhnoye Outlined

*917Q0126A Kiev PRAVDA UKRAINY in Russian*
*20 Apr 91 p 3*

[Article by PRAVDA UKRAINY correspondent Viktor Mishchenko under the rubric "It Is No Longer Secret!" (Dnepropetrovsk): "The 'Work Horses' of Space"—first two paragraphs are PRAVDA UKRAINY introduction]

[Text] "According to CIA reports the production complex in Dnepropetrovsk is described as undoubtedly the largest plant in the world for the production of strategic missiles and launch vehicles." (The journal INTERAVIA SPACE MARKETS, the United States, No 5, 1990.)

Reports on a space theme long ago became familiar on the pages of newspapers and in television and radio broadcasts and do not arouse the former interest among the public at large. Moreover, about 90 percent of them concern manned flights. While the launch of the next Cosmos or even an entire series of them takes place practically unnoticed. Therefore, specialists of the Yuzhnoye Scientific Production Association both for fun and in earnest call themselves the "work horses" of space. In this definition there is also a bit of sadness: For all that, the bulk of space research is performed precisely by devices that were developed by their hands, but hardly anyone knows this. However, when a complete and objective history of the development of space is written, the contribution of the people of Dnepropetrovsk, without a doubt, will be appreciated at its true worth.

### The Lost Blast-Off

The development of launch vehicles and satellites themselves became a kind of specialization of the Yuzhnoye Machine Building Plant (that is what the association was called at that time). In addition to Cosmoses, here, in particular, an entire family of weather satellites was developed. And the first one of them—the Meteor-1—also came from the shops of Yuzhmash [the Yuzhnoye Machine Building Plant].

Later there was a series of vehicles for the study of the world ocean. Now, obviously, there is no need to prove how important and promising this work is. Incidentally, many of our readers will probably remember the ship Somov, which was stuck in the ice of Antarctica. Thus, one of the Dnepropetrovsk satellites helped very much to get it out of ice captivity. The equipment installed on board it also helped to determine the thickness of the ice. Guided by these data, the captain of the Somov was able to plot the safest course among the hummocks and to reach open water.

They also described to me the following incident. The first group space mission had been prepared. However, precisely during this period solar activity increased sharply. Scientists began to worry: Will this affect the safety of the cosmonauts? At the time, after all, the information about what happens in space was incomparably more modest than current information. The specialists of Yuzhmash came to the rescue. In the shortest time they prepared for launching a satellite, which transmitted exhaustive data on the radiation conditions in orbit. Their analysis showed: There was no threat to the health of the cosmonauts. After returning to earth, Komarov, Feoktistov, and Yegorov conveyed to the people of Dnepropetrovsk their personal gratitude for the efficient work.

Then there was the Interkosmos program. Yuzhmash boosters put into orbit equipment developed in Czechoslovakia, France, the GDR, and so on. Then....

At the design bureau they remember this page in their history with unconcealed sadness. For it is a matter of the competition with the Americans on who would be the first to make a flight to the moon, which we lost. One of the most crucial assignments was entrusted to the people of Dnepropetrovsk: to develop the so-called N-1 module, which ensured landing on the satellite of earth and takeoff from it. And they coped with this rather well. But...the Americans, as is known, were the first to visit the moon. The competition lost meaning, and the lunar program was curtailed. While the brilliant work of the Ukrainian designers and workers was unclaimed.

### How To Deliver 100 Tons to Space

The views of the public and specialists on many things often are very different or else simply opposite. For example, in my dilettante opinion, in the Energiya-Buran complex the main role, without a doubt, belongs to Buran. At the Yuzhnoye Design Bureau they explained to me in layman terms that the space shuttle, or, in the jargon of cosmonauts, the "bird," is, strictly speaking, the descent vehicle. But it is easier, in general, to descend from orbit than to get into it. Well, inasmuch as the propulsion plant, which delivered the 100-ton "bird" to space, was developed in Dnepropetrovsk, draw the conclusion yourself, as they say. Especially as Energiya can also fly without Buran. This is not the [U.S.] "Shuttle," which is ineffective without a space shuttle orbiter. The Energiya made its first flight precisely with a conventional space payload.

"I did not happen to be present at this first launch," recalls V.G. Gudim, chief of a department of the Yuzhnoye Design Bureau, "but I flew in to watch the launch of Buran. I remember well the distinct silhouette of the space system against the background of the clear sky. We glanced at the clock impatiently. Launch time! But...the craft remained immobile. Then we heard an explanation: The launch was postponed for technical reasons. So that we had to follow the launch of this complex from the office of the chief designer. We had direct communication with the space launch facility: Suddenly emergency consultation was needed. And here is the launch. The seconds, during the counting off of which the operator repeated: 'The flight is normal,' passed unbearably slowly. And then: 'Separation of the units of the first stage has occurred.' Everyone let out a sigh of relieve: Our system had worked irreproachably."

[Mishchenko] Vladmimir Georgiyevich, there exists the rather widespread opinion that the development of Buran was due first of all to our rivalry with the Americans, which, incidentally, is very ruinous for us. And that in practice it is not necessary.

[Gudim] Believe me, Buran will do a good deal more work in space. As for rivalry, it exists without a doubt. But personally I do not see anything bad in this. Space has already given our national economy a lot. Let us take if only communications. Without space systems millions of Soviet people simply would not have now an opportunity to watch telecasts. And studies of the earth and its climate! And navigation systems! But here is what I would like to note here. Space programs are a kind of locomotive, which pulls to the highest, I simply want to say, the space level many fields of science and technology. Moreover, the new technologies and materials, which were developed for space, then found use on earth. So that I believe: Not space, but the incompetent management of many sectors is to blame for the shortage of the same consumer goods. And the unreasonable curtailment of space research will later strike a blow without fail to all the development of our science and technology.

### Zenits Rush to the Zenith

The development of the Zenit space complex stands apart in the activity of the collective of the Yuzhnoye Design Bureau. First, these were the first rockets that were specially developed for space research and were not "counterparts" of their military colleagues. Second, when designing the Zenits the general-purpose boosters, which also "worked" in the Energiya complex, were used. These are successful vehicles, so that, I think, their use will not be limited only to these systems. Third, the preparation for launch of the Zenits is carried out in automatic mode. These rockets do not require an enormous launch complex, like the well-known Vostoks and Soyuzes. The transport and erection assembly, which is run by electronic systems, performs everything. And the very time of preparation for launching is immeasurably less. And, finally, fourth, the fuel components, which are used in Zenits, are ecologically safe, while in the majority of rockets—both Soviet and foreign—the fuel is usually highly toxic. This circumstance, in particular, played a role of no small importance in the fact the Australians directed close attention to the Zenits. This country plans to build there, on Cape York an international space port. The geological location itself of this site is very favorable for rocket launches. So that this project has a great future.

I, of course, wanted to find out more about the prospects of the Zenits. However, commercial secrets are guarded no worse than military secrets. At the design bureau they showed me only an advertising prospectus, which was published in Australia. Take my word: The Zenit looks simply splendid. Yes, let us wish the people of Dnepropetrovsk that they add commercial success to their technical success. It must be said that the Zenit can deliver to standard orbit (200 km above the surface of earth) a 12-ton payload. For comparison: The well-known Soyuzes and the no less well-known French Arianes lift two-thirds as much.

Since 1980, 14 launches of Zenits have been carried out in our country. All of them, with the exception of one, were successful. So that in our space program these rockets already have also occupied a conspicuous place.

[Mishchenko] Vladimir Georgiyevich, what is in the immediate plans of your firm?

[Gudim] Recently satellites, which were developed here, detected one interesting phenomenon. It turns out that in case of tectonic slips in the earth's crust the disturbance of the electromagnetic field of the planet also occurs. We have established that from these changes of the magnetic field it is possible to predict earthquakes. Moreover, with a great degree of accuracy. Therefore, we now want to offer to the international community the design of a global, if you wish, system of early earthquake warning. It, I think, will arouse extensive interest.

## Tomsk Space Facility NPO Polyus Declassified

*PM0409143991 Moscow Central Television Vostok Program and Orbita Networks in Russian 1500 GMT 2 Sep 91*

[From the "TV Inform" newscast: Report by G. Chudnyy and G. Shkabardin]

[Text] Yet another enterprise has entered the public domain after being secret for decades. The enterprise in question is the Polyus Scientific and Production Association in Tomsk.

[Chudnyy] From the launch of the first satellites and space stations to the flights by the Buran space shuttle there has always been a festive mood in the association's design bureaus, laboratories, and shops. At the association's museum we were shown hundreds of the most varied systems developed in Tomsk and installed on communications satellites, weather satellites, and space stations. These systems have proved reliable tools for geodesists, navigators, and seamen. In the spotlessly clean shops people are assembling spacecraft power supply, attitude control, and propulsion systems. The process of developing new technology requires a supreme level of knowledge on the part of the designers and meticulous skills from the workers. [video shows A.I. Chernyshov, deputy general science director at the association]

[Chernyshov] For instance, take our autonomous power supply system for spacecraft which makes it possible in principle—and, of course, in conjunction with the work done by associated plants—to double or triple a craft's working life. That's a big saving for the national economy, even given the reduced number of spacecraft.

[Chudnyy] The association's collective is currently celebrating its 40th anniversary. The very fact that the developers of these space systems aren't marking their anniversary behind closed doors but are doing so extensively and cordially is doubly gratifying. Their guests included cosmonauts, scientists, delegations from associate plants, and journalists.

## Geneva Disarmament Forum Discusses French Proposal on Space

*LD0508155191 Moscow TASS in English 1528 GMT 5 Aug 91*

[By Sergey Sedov]

[Text] Geneva August 5 TASS—Confidence-building and openness regarding outer space should be promoted by the implementation of the rules for civilian and military satellites, and the setting up of regional "agencies of openness" which would be supplied on the basis of existing agreements on security with photographs made from satellites for analysis and use.

This proposal is contained in a working document submitted by the French delegation to the special committee for the prevention of the arms race in space at a regular session of the conference on disarmament in Geneva.

The authors of the project believe that these measures will help restrain the arms race and lessen military danger in outer space. On the one hand, they will facilitate safety of peaceful activity in space, preventing the use of space for aggressive purposes. On the other hand, they will ease the access of all interested countries to space activity, which will promote cooperation in the use of space for economic and technical purposes.

## Soviets Participate in U.S. Space Shuttle Research Program

*LD2606041691 Moscow TASS in English 1938 GMT 25 Jun 91*

[By TASS correspondent Yuriy Konorov]

[Text] Moscow June 25 TASS—Soviet specialists will carry out after-flight medical and biological experiments on animals that travelled into space on board a Columbia space shuttle. This is the first time Soviet scientists will participate in a U.S. space program.

"This is a unique flight. For the first time U.S. astronauts were seen off into space from Cape Canaveral by Soviet scientists," said Professor E. Ilin, deputy director of the Soviet Health Ministry Institute for Medical and Biological Problems.

"For the first time four physicians and biologists were in the Columbia's crew together with three astronauts. This is the first time that its cargo bay carried a Spacelab scientific and research module with guinea pigs. Finally, this is the first time U.S. specialists have handed over animals that travelled in space to Soviet research institutes," Ilin said.

"The decision was prompted by the fact that Soviet specialists have large experience in conducting biological experiments on white rats, monkeys and other living organisms. Unified methods they apply allow for using computers to systemise data and create data bases. That's why, the participation of our specialists in a U.S. space scientific program is financially and scientifically profitable for both sides," Ilin said.

## Sagdeyev Interviewed on Career as Head of IKI, Current Activities

*917Q0090 Moscow RADIKAL in Russian No 5, Dec 90 pp 1, 2, 3*

[Interview with Academician Roald Zinnurovich Sagdeyev by RADIKAL correspondent Marina Lapina: "Roald Sagdeyev: 'I Have Realized My Dream...'"; first paragraph is RADIKAL introduction]

[Text] **For many years, the name of Academician R. Sagdeyev was a household word. After marrying the granddaughter of former American President D. Eisenhower, Sagdeyev, one of the leaders of the Soviet space**

**program and a USSR people's deputy, found himself in the United States? What does he live on now? What role is he playing in the life of our country? Here is what he told our correspondent during one of his regular, short visits to Moscow.**

**Lapina:** Roald Zinnurovich, after the triumphal Vega and the unsuccessful Fobos, you "left space." Now, owing to changes in your personal life, you are living in the United States. How do you feel in the new capacity?

**Sagdeyev:** I would like to begin the conversation all the same with space, to which I devoted many years. It is not that I want to somehow defend myself with respect to the failure of Fobos or in connection with my leaving, but I would like the readers to have a more or less objective idea of my work in that area.

There exists industry, which makes space vehicles, and there exists science, which develops instruments that are the "passengers" on a spacecraft. Two types of troubles occur during flights. An instrument can fail during a flight, and science bears full responsibility for that. The other kind of trouble that occurs is when the craft or its systems fail, and then, of course, the developers of the craft are responsible for that. It would not occur to anyone, I think, to blame the passenger of a train or an airplane if there were a crash. The very same rules and the very same logic of operation apply here. It is simply that at times in our country everything is covered by a veil of secrecy, as was the case with Fobos.

A remarkable documentary piece about the mission to Phobos has now been published in the United States. Its author is the great-grandson of the famous F. Cooper. He was in the USSR during the project and reconstructed the entire course of events in the form of a documentary. Perhaps, the story is not as absorbing as "Last of the Mohicans," but it has become quite popular.

No one in our country has made an objective analysis of the events. Why not? When the space program was unfolding, a certain circle of journalists were allowed to cover the space area. The ones who were taken to Baykonur, to launches. To a large extent, they were kept on a short leash. As a result, they managed to completely muddle everything.

But there is a determination that is well known to all specialists: There were hidden flaws in the control system of the Fobos vehicles that, after the loss of the first vehicle, made it impossible to save the second one. Lapygin, the general designer of control systems, was, incidentally, elected a USSR people's deputy after that from the Tuva Autonomous Republic. That has always surprised me. On what basis was he elected? On an ethnic basis?

**Lapina:** What is so surprising about that? That is not the only such case. You remember the reaction of the deputies to a similar remark by Sobchak with respect to our former leaders (I think it was Vorotnikov and someone else) who were elected, apparently, on the same bases. It was taken as an insult.

**Sagdeyev:** Moreover, Lapygin was chosen (or appointed) as chairman of the commission of the Supreme Soviet for defense and the KGB. I take that to mean that he did a poor job of controlling a complex piece of space hardware, but is, apparently, having an easy time of managing the military-industrial complex.

For our institute the loss of the vehicles was a tragedy. It had taken years for young scientists to develop certain instruments, several of which "found themselves in space" for the first time ever, and that is where everything ended up. Many experienced a true mental breakdown.

I understand the question is being asked, Why were so many honors rendered to individuals and even groups after Vega? Here again there is much that is not objective. What was the difference between Vega and Fobos? At some point, it was demonstrated to executives of industry that to fly through the enormous dust envelope of the comet and to find in it the minute nucleus would be an impossible task. At that point, we and our foreign colleagues succeeded in assuming the role of not only passive passengers, but also active pilots who were allowed to steer the craft. Unfortunately, with Fobos we were thrown back to where we had started. They told us right away, at the developmental stage, that hardware is not your business. I do not want to blame the designers. They were doing their best, and they of course had no ill intentions. To some degree, the results were affected by the fact that the military-industrial complex was working primarily on its own professional tasks, extorting money from taxpayers for the protection of the achievements of socialism. Which ones in particular? The SS-25 missiles that drove across Red Square on 7 November? The empty shelves of GUM [State Department Store], which they went past?

**Lapina:** But Roald Zinnurovich, let us talk about you. For many years, you were one of the leaders of the Soviet space program. From all appearances, you gladly cast aside that burden. And what now? Are you free? Are you happy?

**Sagdeyev:** I am a theoretical physicist, and I had always studied questions of plasma physics. As a scientist, I grew up in the collective of the Institute of Atomic Energy, which was established in order to implement the Sakharov-Tamm proposal on controlled thermonuclear fusion. The problem has proved to be very difficult, and to this day, people are racking their brains all over the world to solve it.

Then I worked in Novosibirsk, and my scientific interests gradually broadened, and I also dealt a little with cosmic plasma, but was far from anything to do with the practical space program. But in 1973, M. Keldysh invited me to head IKI [Space Research Institute]. At

first, the job held no interest for me. I agreed with much hesitation to take it, considering it a kind of duty, an obligation.

**Lapina:** Maybe you just could not bring yourself to turn Keldysh down?

**Sagdeyev:** You know, there were many psychological nuances. Indeed, it was very hard for me to turn him down, because I had at that time returned to Moscow after a 10-year stay in Novosibirsk and was virtually "out of a job."

**Lapina:** Does that mean that you regarded the appointment as one of the necessary steps in your science career?

**Sagdeyev:** If we talk about a science career, then it represented some steps down. I realized that I would have to engage in administrative work, and I naively believed that I would be able to complete that obligation and, in a few years, return to scientific work.

**Lapina:** If the situation at the time of your appointment had been better for you, would you have not agreed to take the job?

**Sagdeyev:** I think so, if I had had alternatives and I had been able to resist the administrative pressure.

**Lapina:** Was there pressure all the same?

**Sagdeyev:** There was the implication of it. Mstislav Vsevolodovich had been able to blend with the rigid framework of the command-administrative system that existed, without losing the mentality of a real scientist. There would have been pressure if I had not agreed, for Keldysh had already earlier gotten agreement on my candidacy in the Central Committee and other offices.

Experience showed that directorship is a very heavy burden, and by no means a sinecure. During the first years I did not have a minute left for science. I learned something of administrative work and of organizing space projects. But at times, I was simply overcome by despair because I knew that as a scientist I was deteriorating. I attempted several times to leave the post of director.

I made such an attempt in the late 1970s, after Keldysh had died. He had supervised space science and was my immediate chief after leaving the post of president of the USSR Academy of Sciences. We had built up a relationship that was quite confiding, if unique. With the departure of Keldysh I found myself simply in a vacuum. A. Aleksandrov, who succeeded him, admitted frankly that the only thing he had to do with space had been to raise toasts after every launch. It was very difficult to work in such an atmosphere. I was still a comparatively young director and found myself without moral support and without a mentor.

**Lapina:** And did you give notice?

**Sagdeyev:** Yes, it had already been considered in the bureau of the General Physics and Astronomy Department, where I had friends and colleagues who understood all the ambiguity of my position. But I did not manage to overcome the next obstacle—Academician Aleksandrov. He asked me not to make any attempts for some time.

Then the mission to Halley's Comet became possible. On the creative level, it was the most interesting thing I did here.

**Lapina:** You undoubtedly know about the pieces that have appeared in our press recently with reproaches meant for you. Essentially, they say that IKI had a very rigid command-administrative system, with all its expenditures, and you were the indisputable leader, a monopolist who would not let young people show what they could do. The authors of the articles see that as the root of many of our failures in space.

**Sagdeyev:** For the most part, those pieces were printed in publications such as MOLODAYA GVARDIYA and LITERATURNAYA ROSSIYA. I regard them as a kind of award.

**Lapina:** But IZVESTIYA is also among those publications.

**Sagdeyev:** To this day, that article to me is inexplicable—or rather, the role of IZVESTIYA is inexplicable. When you see who the author is, everything becomes clear. I do not want to go into the details, but he is quite well known in the science world and does not express the viewpoint of those at IKI. They found two or three other people. It is funny that among them was an individual who for many years was a sector head in the Science Department of the Central Committee. And he is talking about command-administrative methods!

**Lapina:** I would like to hear a few words about your activity as a people's deputy. How do you perform your duties when you don't live here in the country?

**Sagdeyev:** I am a member of the Supreme Soviet committee for international affairs. I went to its chairman, A. Dzasokhov, asking what I should do in such a situation. Should I, perhaps, withdraw? We came to the understanding that I will represent our legislative authority in the United States and other countries. I have to appear a great deal both in person and in the press with comments on our internal events. In particular, when B. Yeltsin was elected to the post of chairman of the RSFSR Supreme Soviet, my wife and I wrote a long article in the WASHINGTON POST about that event. It did not go unnoticed. In the West, they prefer at times to believe individuals. And someone has to do that work.

There were attempts to raise the question of my recall; Academician Dorodnitsyn and his group were particularly active in that. Incidentally, they had spoken out against me and Sakharov back during the election campaign and even on election day, when any canvassing

either "for" or "against" is prohibited. But now, as then, the voters have not supported them.

**Lapina:** Roald Zinnurovich, you are still working at the University of Maryland....

**Sagdeyev:** Yes, I have realized my dream—I work as a theoretician and give lectures on plasma physics twice a week. In general, life in America for me is like life on another planet. I do not want to say that my past life was uninteresting. But I am like a traveler who is making new discoveries.

**Lapina:** And what does your wife do?

**Sagdeyev:** She has a small firm. She does consulting work, as well as literary work. Susan grew up in a literary family. President Eisenhower did his best to write his own speeches, and when he was a young soldier, he prepared the texts of the speeches by the famous General MacArthur.

**Lapina:** Are you aware of what the name Eisenhower means today for America?

**Sagdeyev:** Of course, I am. In the United States they respect political figures of the past, no one throws them from pedestals as they do in our country. My wife is proud of her name.

**Lapina:** Have you not noticed since you have been living in the United States an increased interest on the part of such an organization as the KGB? After all, for many years you were given access to secrets....

**Sagdeyev:** Even if someone does have an increased interest in my person, he is carefully concealing it. Thus far, there has been no trouble, although my wife and I were afraid of both sides. As for secrets, I had occasion to have contact with representatives of defense enterprises, but secrets as such never interested me, and I tried to keep as far as possible from them. Of course, not because I knew that some day it would prove useful to me. Incidentally, it is not at all mandatory to have access to any secrets to have trouble from the KGB.

**Lapina:** Where do you usually stay when you come to Moscow?

**Sagdeyev:** With friends or at a hotel. I cannot ask for something more than that with the housing crisis. And certainly not for the situation that has been created for a defector from American intelligence, who in a quite recent interview to the WASHINGTON POST newspaper said that he had been given a three- or four-room apartment in Moscow and a two-story dacha in the country. I have no right to expect such a thing.

## Career Highlights, Current Activities of Chief Designer Lozino-Lozhinskiy

*917Q0143A Moscow KRASNAYA ZVEZDA (First edition) in Russian 31 Jul 91 p 4*

[Article by Colonel M. Rebrov: "The Revolutions of 'Spiral'. A Biography and Portrait of the Chief Designer of the Buran Space Plane"—first paragraphs are KRASNAYA ZVEZDA introduction]

[Text] Why is what is called the burden of fame distributed so unevenly among people? It comes easily to some people—they have only to flash by in a fashionable television clip or appear for a few minutes on the screen in a telecast of questionable sense, while others, those who for years and decades gave the country scientific and technical priorities and under frantic conditions created that which brought the nation fame, were unfairly left "off screen." I do not know whether it is by reason of "secrecy" or for some other reason. I noticed another thing: The vacuum all the same was filled, true, with other names that at times do not have the full right to this.

We have gotten accustomed to the fact that name of the author is on the cover of a book, that every artist places his signature or initials in the corner of a picture. We have far more rarely the opportunity to find out the names of the makers of physical assets. And it seems impossible to say that we do not have at all the tradition of commending with "a token of remembrance" the creators of science and technology. There are memorial inscriptions on bridges, architectural structures, and several metro stations. Aircraft are designated by the initial letters of the names of the developers. There are also other examples, they are in the public eye.

I first heard about Gleb Yevgenyevich Lozino-Lozhinskiy from Major General of Aviation Grigoriy Aleksandrovich Sedov, honored test pilot of the USSR, who was in charge of the test flight service at the Mikoyan "firm." That was in the early 1960's. I had encountered this name more than once in textbooks and monographs—more often as a short line. But then in the American reference work *Who's Who* it is also possible to find out the details. Incidentally, glasnost is sweeping away the old laws.

### What Did the Australian Reconnaissance Aircraft See?

With how many secrets and top secrets the radio ether above the planet is filled! Sacred naivete is casting a spell over many people—they do not write about this in the newspapers, thus, no one knows anything. But somewhere something is happening, someone is flying or sailing somewhere, a report about something is being given to someone.... A large number of events, ingenious plots and denouements, causes and effects....

The Australian reconnaissance plane did not simply fly back and forth in the sky above the ocean, but went to a

designated grid square, at a specified time, knowing that a special Soviet ship was there. For what? It was this that had to be found out.

...The note in the magazine SCIENTIFIC AMERICAN roused curiosity and was puzzling. Incidentally, the commentary on the report was puzzling as well.

"The small reusable space plane is another addition to the Soviet complex of space hardware.... Its existence was uncovered several years ago, when a photograph of a model of the space plane, which was made on a reduced scale, was taken from a plane of the Australian Air Force, which was flying over the Indian Ocean.... Western specialists believe that the SL-16 rocket can be used for launching the space plane into near-earth orbit; a crew of two or three can be aboard the plane...the plane is probably capable of landing on a standard runway. It can also be used for carrying people from one space installation to another.... A model of the space plane was photographed on the deck of a Soviet ship, onto which it had been lifted from the water, having completed a test flight. The actual space plane is probably two- to three-fold larger than the model...."

That in brief is all. The "standard" response to the inquiry of western journalists to "the highest authorities" was received: "The report belongs to the category of canards." I do not know to what this assertion was due. In not so distant times it was considered the norm to shadow, to be secretive, and to lie. Incidentally, these were secrets from ourselves, in the West they knew a lot, for it is impossible to conceal the tests of such hardware.

Many years later I asked Gleb Yevgenyevich to clarify the situation. For in the magazine, in addition to the text, there was also a photograph:

"SCIENTIFIC AMERICAN attempted to depict the unexpectedly discovered new air/spacecraft as a type of already existing space-based weapon. In reality this is one of the tests of the heat shield of Buran and the shape of a future small orbital plane. In all four launches, which were entered in the catalog under the index of Kosmos satellites with the numbers 1374, 1445, 1517, and 1614, were carried out. As to the idea of developing a small space plane, here the magazine is correct: It originated in Russia, acquired specific design forms, but...."

Thus, the photograph from aboard the Australian plane was taken on 4 June 1982.

### The Curtain of Silence

At all times they have called the truth bitter. It always hurt. But is it really not that way today? Gleb Yevgenyevich has his own opinion in this regard:

"The truth will carve its way, sooner or later it will triumph, everything will be called by its proper names."

"But why do you agree to this 'later'? Is time really not of any importance?"

"It is. But if you recycle only on the truth of history, you will do nothing good today...."

Doctor of Technical Sciences Lozino-Lozhinskiy, General Director and Chief Designer of the Molniya Scientific Production Association, Hero of Socialist Labor, and academician of the USSR Engineering Academy, in recent years has been doing an especially large amount of work. At times you are amazed by how he maintains such an intense work pace at his elderly age.

"All this is difficult," Gleb Yevgenyevich agreed, but at once found an excuse. "There is no other way out. The present situation with its uncertainty, contradictory nature, and not always competent understanding of conversion is wearing people out, is making production feverish, and, what is the primary thing, on the threshold of the most difficult tests for the country by the market threatens to leave many most important sectors without an adequate intellectual potential, without highly skilled personnel...."

I listened to his deliberate speech, compared it with what I had found out about him from those, who had gone through many ordeals with him, and here is what I thought about. The life of a designer is gradient: elevated thoughts and everyday routine, fighting and temporizing, complaining of despotic omnipotence and forced obedience, the condemnation of militant incompetence and subordination to it. The gradients of existence, which are characteristic of the times, do not worry me. They are to some extent natural. But there were both unbroken people and fighters. Over many years, which flew by so unnoticeably and noticeably, Lozino-Lozhinskiy did not betray his principles: not under Stalin, not under Khrushchev, not under Brezhnev.

"The old.... Yes, no one will save the old from the bitter truth, which we have found out about it. No one! About myself I will say: My soul was castrated, my eyes gazed both at the lofty and at the base. But my life has been lived not in vain, to the dictation of conscience and dignity. I will not renounce it. A man from the past, would you say? No, I will not accept such a thing. But I also do not want to be a man without a past...."

### A Little About the Past

"A man without a past." You would not say this about him. He experienced everything that his times held: He lived through the civil war, the famine, the dreadful period of repressions, when whoever just yesterday was next to you suddenly turned out to be "an enemy of the people," while others, having surrendered to "stinking fear," in saving themselves scribbled slanders and denunciations.

In 1937 he participated in the designing of a steam powerplant for aircraft of A.N. Tupolev. The fate of Andrey Nikolayevich and the "Tupolev sphere" is

regrettably well known. An anonymous note or telephone call was sufficient to deal with Lozino-Lozhinskiy. Later he would say: "To the honor of my comrades, no one did this." But then....

He proposed an original design solution, which made it possible to reduce the dimensions of components and to obtain a power gain; he substantiated the expedience of an afterburner for jet engines. However, the idea was implemented only nine years later. Incidentally, other developments of his were also ahead of time, although the very same "time" created obstacles for them.

The Great Patriotic War found him in Kiev. Bombings from the first day, fires at the plant, blood-stained people.... In the same 1941 he began working at the special design bureau of Artem Ivanovich Mikoyan, implementing his own ideas in the famous MIG's. The four war years, which were long as a life time, passed in agonizing succession. Engagements on the approaches to Moscow, agonizing uncertainty, stupefaction from constant insufficient sleep and overexertion, meager ration bread, which was mixed with chaff. It was necessary to frantically scale and alter already finished assemblies, when the needed metal was not available, while airplanes had to emerge from the shop no matter what.

They survived, held out, got through.... But this, apparently, seemed too little for fate, and it prepared for Lozino-Lozhinskiy a terrible automobile accident. He also got over this ordeal. The plaster "armor" prevented him from moving, his muscles swelled. But he endured with the greatest difficulty of all the forced idleness. And then once, in defiance of physicians, bandaged and unbending he appeared at his workplace at the design bureau.

During the postwar years, when rocketry began to be developed rapidly, Khrushchev hastened to make a decision on the reduction of the Air Force, the reorientation of aircraft design bureaus and plants, and the closing down of many themes. At one of the conferences Lozino-Lozhinskiy attempted to object ("In spite of all the enthusiasm with regard to rockets, one should not forget the little wings. They are still of use to us"), but did not get support.

**The Approaches**

At times a kind of pathological lack of faith in ourselves appears among us. However, this is said in a too generalized manner—rather it appears among those few people, to whom the right to decide the technical fates of the country has fallen because of official position, and not owing to thorough competence.

Soon after the war Andrey Nikolayevich Tupolev, who was recognized by the entire work as Designer No. 1, was ordered to copy the American B-29 bomber. Tupolev objected, having given as the reason for this the fact that he had his own design of a more advanced and more promising vehicle. However, he was unable to change Stalin's mind. Thus, in 1947 the Tu-4—a heavy bomber like the "flying fortress"—appeared.

During approximately the same years they imposed upon S.P. Korolev as an analog the German V-2 rocket. At that time the R-1 also was born, although the domestic R-2, which was developed by him, in many respects surpassed the "secret weapon" of Hitler.

Something similar also happened with the project that received the code name "Spiral." In the early 1960's the idea of an airplane for flight into space originated in the special design bureau of Mikoyan. Lozino-Lozhinskiy was appointed chief designer of the project. During those years the Americans sped up their own project of a small orbital airplane, the Dynasoar. It was proposed to put it into orbit with a Titan-3 rocket. Lozino-Lozhinskiy had his own version, even two. A booster airplane was envisaged in the first, a Soyuz rocket with an orbital airplane was envisaged in the second. The project was brought up to the stage of the production and flight tests of a full-scale manned analog. But in the early 1970's then Minister of Defense Grechko issued an order, which prohibited all work on the project, having declared that "it is necessary to engage in real work, and not in fantasy."

And that is that. We lost our ideas and time, while "they," our western competitors, have now successfully implemented plans that are no longer ours. Their Shuttle and our Buran are an example of this.

When the decision on the development of the Soviet aerospace system was made, the Molniya Scientific Production Association, which Lozino-Lozhinskiy heads, proposed to take as a basis its "ancient" (13 years had been lost) design. However, it was rejected with a quite strange explanation: "This is not at all what the Americans are doing." "No, it is not," they agreed at the firm. "But our version is more promising." And it is here that this very lack of faith in ourselves "snapped into action" (not for the first time!). "Does it turn out that they are fools? But their Shuttle is already flying."

The Shuttle has actually already flown. The modernized "Spiral" project required considerable efforts, although it was appealing for its design boldness and farsightedness. The desire to obtain more rapidly a final result, be it even not a very original one, won. And all the same I would not compare Buran with the Shuttle. Yes, they are similar in appearance. As, for example, many airplanes are alike—each has a fuselage, wings, propulsion units, a landing gear.... Buran has something of its own, something unique, and it surpasses the American design in a number parameters.

"The happiness of a designer?" Gleb Yevgenyevich shakes his head. "Happiness does not have occupational affiliation, and in general it is very individual and unique—the feeling of happiness. Who will venture to define what this is?..."

He casts a glance at the photographs of airplanes on the walls of his office and continues:

"Without all this there would be no Buran," but at once, having laughed, he adds: "This, of course, is an exaggeration...."

Of course. There is a time and place for everything. However, without any exaggeration it is possible to assert that without him, Lozino-Lozhinskiy, today there would be no Buran.

**The First Revolution**

"Spiral" is the unity of aeronautics and astronautics, the breaking through to the starry heights above the clouds without a rocket launch, from a conventional runway. The project originated when the very idea was considered impudently fantastic. But in this there is a particular aroma for the designer. Suppose its implementation came up against a large number of problems, which evoked among skeptics not exactly despondency—certain impracticability. Suppose many people did not conceal derision. There were also steadfast advocates of "Spiral." Specialists of the Central Aerohydrodynamics Institute, who conducted a series of experiments in a wind tunnel in search of the optimum shapes of the model of the booster airplane, supported them. The general concept was the following.

As the first stage it was proposed to use a hypersonic booster airplane, then there is flight in space and return to earth like an airplane. According to the idea of the designer, the small orbital plane with folding wings should have appreciably reduced the cost and simplified the delivery of payloads to space.

A subsonic analog of the future space plane was produced at the design bureau. They carried it aloft on a Tupolev Tu-95 bomber and released it, the subsequent flight and landing were accomplished in manned mode. The first tests yielded positive results. The second phase: studies of the behavior of the vehicle at hypersonic velocities, lay ahead. It remained for Lozino-Lozhinskiy and his colleagues, as they say, to take the last step. It was then that the very order followed: to halt further work on the "Spiral" project.

**The Second and Third...**

Buran was making a landing approach. It traveled exactly to the predesignated point on the concrete runway. The designer suddenly felt awfully tired. The feeling that seized him defied description, in it there was something of maternal love, of paternal pride, of the trembling adoration of a sweetheart, of the intoxicating rapture of a child, to whom something previously unknown has been revealed, and much, much more. This inexpressible feeling returned him to the past and at the same time carried him ahead, while casting aside doubts and anxieties.

On 15 November 1988, having completely two revolutions around earth, the Buran space shuttle returned to Baykonur and landed, obeying the automatic controls. And only then was the name of the man, who was in charge of the work on the development of our space plane—the glider, the aerodynamics, the heat shield, the controllability and stability, the automatic equipment...—revealed.

"In collaboration with many organizations," Gleb Yevgenyevich interposes as soon as I touch upon this theme. And he names his colleagues and assistants—G.P. Dementyev, Ya.I. Seletskiy, L.P. Voinov, Ye.A. Samsonov, Yu.D. Blokhin....

Today the talk about Buran has quieted down. Somebody commented on the long interval between its flights: The reusable craft has turned out to be a one-time craft. Then rumors began to spread that irreparable defects had supposedly been detected and they had shut down the program altogether, for the craft is not suitable for manned flights. I admit: I did not decide straight away to ask the Chief Designer these questions, but I could not but ask about what was on everyone's lips.

"Everything with Buran is in order," Gleb Yevgenyevich sighed. "The program of its week-long flight, which provides for docking with the Mir complex and the visiting of Buran by the crew of the orbital station, is ready. The delay is due to financial difficulties and nothing else. Why is it that way? The one-sidedness of thinking and ingrained stereotypes are having an effect: The expenses are calculated very fastidiously, but they cannot even estimate the potential revenues in case of the proper organization of the work...."

"And what is in the plans of the Molniya Scientific Production Association?" I asked Gleb Yevgenyevich.

"There is no shortcoming in this. We understand conversion not as a breakup, but as the derivation of the maximum benefit from what we have. The joint Soviet-Bulgarian Informatika Center has been set up, we are participating in the activity of the commercial and industrial association, which the American bank Meere Capital Corporation is supporting. During the development of Buran we became the owners of unique technologies, know-how, inventions.... It is possible not only to use all this effectively in the national economy of the country, but also to export it. What else? We are developing the six-seat Molniya-1 airplane, which, I hope, will be a good help to geologists, cartographers, first aid physicians.... Calculations show that the domestic and foreign markets are prepared for the annual acquisition of up to 2,000 such vehicles...."

The Chief Designer also spoke about the new revolutions of "Spiral." The winged space shuttle will make it possible to reduce to one-fifth and even one-tenth the expenditures on putting a payload into orbit. This is in comparison with the rocket version. For example, it is possible to use the giant An-225 Mriya airplane for putting into space such craft as the English Hotol.

Lozino-Lozhinskiy has his own design of the MAKS—multipurpose aerospace system, a logical continuation of "Spiral." At the scientific production association they are also studying a version of a multiseater suborbital airplane with seating for 52 people.

I listened to Gleb Yevgenyevich and caught myself thinking the following. Everything that is being done at the Molniya Scientific Production Association corresponds not simply to the scale of the plans and the practicability of matters, but no less also to the personality of the general director and Chief Designer. He handles professionally, as the matter requires, enormous material and human resources. However, this is not enough for him. In addition to that he is introducing irrepressible creative aspiration and the joy of discovery and surmounting into literally everything. In whomever this is, it has not faded—he is independent of time, it is filled in him with the light of hope and aspiration for tomorrow.

## Lozino-Lozinskiy Discusses Buran Program, Suborbital Passenger System

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[Interview with Academician of the USSR Engineering Academy Gleb Yevgenyevich Lozino-Lozinskiy, general director and chief designer of the Molniya Scientific Production Association, by M. Makhlin, under the rubric "MOSKOVSKAYA PRAVDA Dialogues": "Buran's Flag Stops"; first paragraph is MOSKOVSKAYA PRAVDA introduction]

[Text] The individual interviewed today is Academician of the USSR Engineering Academy Gleb Lozino-Lozinskiy, general director and chief designer of the Molniya Scientific Production Association.

**Makhlin:** Gleb Yevgenyevich, as we all know, since 15 November 1988, when the program was successfully completed and a landing was made in automatic mode,

Buran has not been in space. Why has the reusable craft become an expendable craft? Were flaws found, perhaps, that could not be eliminated?

**Lozino-Lozinskiy:** Everything is in order with Buran. The program is almost ready for its new, now week-long flight, which calls for it to dock with the Mir complex and for the crew of the orbital station to visit Buran.

The launch was expected for the end of last year. Now it has been postponed to the end of this year.

**Makhlin:** You will agree that such a long interruption compromises your creation. And once again a postponement....

**Lozino-Lozinskiy:** A certain period of time, of course, was needed for the development of the software of the new program and individual technical improvements.

And here, it can be said, they clipped the wings of Buran. Under the aegis of conversion, the spending for defense areas was cut. And that, in my opinion, undeservedly and groundlessly affected space research, including the Energiya-Buran program. The whole problem with the Soviet spaceplane lies in the fact that it was developed deep in the interior of the military-industrial complex.

One-sided thinking and ingrained stereotypes are having their effect. It would not occur to anyone to curtail the development of new trucks or passenger planes, although they can transport soldiers and their cargo. Like other multipurpose equipment, Buran is capable of serving both defense and the national economy. For some reason, only the first, most narrow aspect was taken into account.

What many have affected that approach was the coverage given in our press to the flights of the American space "shuttles," coverage that emphasized their importance for the development of SDI, so-called Star Wars. The commercial aspect of the question was passed over in silence. And now the "space shuttles" are putting more than just spy satellites into orbit, and Pentagon orders are ceasing to be decisive.

Does our country really not need the practical development of outer space—never mind scientific research? Television, communications, ecological monitoring, the production of drugs, the growing of crystals—a far from complete list of the vital terrestrial tasks that are handled by space vehicles. We continue to put them into orbit by means of conventional rockets. With advanced technology at our disposal, we are using yesterday's methods. And none of the powers that be is pondering why—added to the Americans now—England, France, Germany, and Japan would suddenly be concerned about developing their own "shuttles." Winged space shuttles make it possible to reduce five- to tenfold the cost of delivering a payload into orbit, as compared with doing it with a rocket. I should add that in our country millions of hectares have been alienated or removed from production just because spent stages of launch vehicles have dropped on them.

It is no exaggeration to say that a new era in the development of outer space has begun. We have crossed that threshold and stopped. What could be more irrational! As the well-known proverb goes, penny-wise, pound-foolish.

We still have just one Buran. A second one is being assembled in Baykonur. A third one is being manufactured in our shops. The United States after the loss of the Challenger has four "shuttles."

**Makhlin:** Once already, you let the Americans get ahead. At that time, you were working at the A. I. Mikoyan Special Design Bureau. And now in the bureau's museum, one can find your portrait among the "Mikoyan men"—Heroes of Socialist Labor and winners of the Lenin Prize. While close by on stands, there are models and photographs of a spaceplane and cruise missiles.

**Lozino-Lozinskiy:** Let us assume that cruise missiles are a special item. In the arms race, our country historically never strove for leadership, being content with parity. But then the shutdown of work on winged space vehicles, as experience has shown, was a mistake. What guided Brezhnev and Grechko when they made such a decision? For the defense of the country, there would be plenty of intercontinental ballistic missiles capable of hitting any point of the globe. The national economic peaceful purpose of spaceplanes was simply not taken into account. Sergey Pavlovich Korolev had some understanding for our problems, but he did not have enough authority.

Interest in our domestic stock of research was awakened only by the American "Star Wars" plans. That is when the real race began. Our scientific production association, after all, is a little more than 15 years old. But now, it would seem, new foreign policy thinking has triumphed. But no, domestic economic stagnation is counterbalancing it. One set of blinders was traded for another. First the idea of Buran did not seem aggressive enough, now it seems not civilian enough.

**Makhlin:** The lost preeminence, of course, is a pity. But it's really not just in that area that we lost it, assuming that no prophet is accepted in his own country. That is why the first steps of perestroyka, which were aimed at the acceleration of scientific and technical progress, were perceived as the beginning of truly revolutionary changes in the national economy. Indeed, look at how many ideas the garbage dump was able to tolerate! Now, it appears, we are waiting to let someone else get ahead.

**Lozino-Lozinskiy:** That is most regrettable. At the moment, foreign firms are displaying a great deal of interest in Buran. Say what you like, but it is unsurpassed in many respects. For the time being. And specialists understand that and appreciate our present openness to cooperation and the quality of the technical solutions that are being found. But who can guarantee that while the hectic search for sources of financing by Soviet scientists and designers is under way, a better version

will not appear somewhere? Entirely real contracts for many millions, if not billions, of foreign exchange rubles are threatened. For in the West this work is being stepped up. We are to this day in a suspended state owing to peculiarities that are characteristic only of us.

We have been receiving money from our own Ministry of the Aviation Industry, while Energiya has received money from its own Ministry of General Machine Building. And we coped with the task that was posed. We were even conferred awards. Now it has occurred to someone to finance Energiya-Buran together along the lines of the Ministry of General Machine Building alone. Understandable uncertainty has arisen. The farther things go, the more uncertainty there is. The project of merging both sectors into one Ministry of the Aerospace Industry seems to have ripened. I do not presume to judge the advisability of such a decision.

But why, be so kind as to tell me, should the matter suffer as a result of organizational perturbations? After all, since the beginning of the year we have been living on credit, and it has run out. I am ashamed to admit that the developers of Buran are worried about how to pay the wage to the workers and employees, whom they just commended with state awards. Economic ties are being severed because of our insolvency. Why is this nervous strain necessary?

**Makhlin:** You are asking me?

**Lozino-Lozinskiy:** No, the question is rhetorical. Neither the Cabinet of Ministers nor the USSR Supreme Soviet is giving an answer to it.

**Makhlin:** The most ridiculous thing is that, ultimately, they will appropriate the funds, they will not leave the collective without wages, and they will not halt the work on Buran. But first they will worry you and your colleagues needlessly. Enterprises of civilian sectors have more than once found themselves in a similar position. Now "defense" will also have to drink of that cup. Get used to it, or become independent, if only financially.

**Lozino-Lozinskiy:** Of course, we do not intend to become accustomed to disgrace and to sit twiddling our thumbs. The Molniya Scientific Production Association has organized the joint Soviet-Bulgarian Informatika Scientific Production Center. We and the Ministry of the Aviation Industry are establishing the Oreol Commercial and Industrial Association, with the involvement of the American bank Meer Capital Corporation. After all, during the development of Buran we became the proprietors of unique technologies, invented a number of things, and introduced a multitude of assemblies, parts, and materials that can be used quite effectively in various sectors of the national economy or can be exported.

The following facts testify to how broad the range of our conversion capabilities is. The system of the optimization of the operation of reactors of chemical and petrochemical works is valued at 43 million rubles [R]. That made it possible to boost the capacity of those works and to increase the product output by 8-9 percent. Such results are better than any ad: Contracts through 1992 inclusive, worth another R120 million, have been concluded.

Individual injectors, whose development stems from the use of new materials that appeared especially for Buran, are holding up to clinical tests. In 1991 it is planned to produce 100,000 such injectors. Their use will make it possible to reduce sharply the need for disposable syringes and, accordingly, to save the resources that are used for their production.

For 1991, some 20,000 flat heating elements for household needs, plus equipment of small production facilities, have been ordered. They are particularly convenient for rural buildings. They were made in the image and likeness of similar elements that are used in Buran.

It is possible to cite a large number of other examples. We have accumulated diverse small orders worth R15 million. With what are literally treasures of modern scientific and technical thought at our disposal, we are disturbed by the weak interest displayed toward them by civilian sectors. Rather, there is an interest, but it is not backed materially. I think the government could allocate special-purpose credits for the introduction of the achievements of Buran in the national economy. In many respects, our proposals are more efficient than those now being acquired for currency from foreign partners.

As early as this year, our scientific production association will make a prototype for a light-weight, six-seater airplane that meets the needs of geology, health care, and cartography, and the Machinery Plant imeni Khrunichev will it put into series production. Abroad, the demand for airplanes of that class is also large. In 1993, the production of such aircraft will come to several hundred, half of which will be exported. Then it will be necessary to produce 1,500-2,000 such airplanes annually.

**Makhlin:** And when will Buran become manned?

**Lozino-Lozinskiy:** We are preparing a program for the flight of a two-man crew after the Energiya-Buran complex achieves the desired level of reliability.

**Makhlin:** The Americans fly with a larger crew. And at the Flight Research Institute imeni Gromov, two groups of five individuals have been trained for Buran.

**Lozino-Lozinskiy:** In contrast to the American "shuttles," the plans for Buran call for a crew rescue system based on ejection. That means additional weight. The airframe itself is designed for at least 10. But we must go sequentially through all the testing stages and keep the risk to a minimum. And again we are running into problems of financing.

**Makhlin:** In September of last year, at the Farnborough Air Show near London, I was present at the signing of an agreement between the USSR Ministry of the Aviation

Industry and British Aerospace that calls for a study of the possibility of launching a reusable Interim Hotol spaceplane from our Mriya—the An-225, the largest airplane in the world. That would make it possible to do without a ground launch complex and a launch vehicle. But how about Buran, for the transport of which the Mriya was built?

**Lozino-Lozinskiy:** The Interim Hotol, if the project comes to pass, will put into orbit a payload that is several times smaller than what Buran is capable of putting into orbit. We are working on a multipurpose aerospace system. We are technically ready to implement an even more daring project—a reusable, two-stage, suborbital global passenger system with horizontal takeoff and landing. Such is the official name. But put more simply, a suborbital passenger airplane with 52 passengers and two pilots would launch from a modified AN-225 Mriya carrier-aircraft. A flight with the Mriya taking off from one of Moscow's airports and the passengers being landed in, say, New York, Sidney, or Rio de Janeiro would take no more than two hours.

**Makhlin:** Cosmonauts undergo special training, but what will it be like for mere mortals? And, besides, wouldn't a ticket for such a trip probably cost an astronomical sum?

**Lozino-Lozinskiy:** The flight follows a ballistic suborbital trajectory at an altitude of up to 160 km. The passengers experience a G-force of not more than "2," and for up to 25 minutes they are in a state that is close to weightlessness. For essentially healthy people, that is not a problem. As for a ticket, it, as you yourself understand, is not cheap. However, it is within the reach of those people who must fly 20,000 km in a couple of hours: $40,000-$45,000.

**Makhlin:** That is science fiction!

**Lozino-Lozinskiy:** Not at all. We are officially inviting foreign enterprises and firms to participate on the basis of a consortium in the development of the system.

**Makhlin:** How much time will it take?

**Lozino-Lozinskiy:** The earlier we begin, the sooner we will finish. In any case, I hope to be one of the first passengers, and I am already over 80. If they give me a free ticket. Alas, everything again depends on money.

## Career of Cosmonaut Candidate Not Selected for Space Flight

*917Q0082 Moscow SOVETSKAYA KULTURA in Russian No 15, 13 Apr 91 p 6*

[Interview with Col (Res) Mikhail Ivanovich Lisun, candidate of technical sciences, deputy director of the Memorial Museum of Cosmonautics and head of the Academician S. P. Korolev Memorial Home Museum, by Yuriy Karash, SOVETSKAYA KULTURA special correspondent and finalist in the USSR Union of Journalists' Space Contest: "The Man in the Iron Mask"]

[Text] **There is no such book yet. And no one knows if it will be written. Nevertheless, it exists. Its title is "The Chronicle of the Domestic Manned Space Program." The decades make up its chapters (yesterday, the period was placed at the end of the third chapter); the years, its pages. And its lines consist of the people, their work, their thoughts, their feelings, their feats.**

**But if anyone had undertaken such a labor even a few years back, the section devoted to the space explorers would have had blank spaces for certain names right next to some of the familiar names. Who are those people? Why have many of those who have given the best years of their lives (and some even their lives) to the space program turned out to be outside the boundaries of its history?**

**Thanks to the art of montage, those people, photographed right next to the pilot-cosmonauts, often disappeared later from the photos. It was as if they had never even been there at all. Remember the story from the time of Louis XIV about the man in the iron mask—the twin brother of the king? That is what those people are—second and third copies of the heroes—willed by fate to remain always in the backup and standby crews. They have been hidden all these years. It is difficult to say just what the reason for that was. Maybe it was also part of the secret, the dense fog that shrouded our space research. But that's not what is important now. We would do better to think about the present day. Wouldn't it be fair to mark the 30th anniversary of Gagarin's lift-off with a story about them, too, those who spent all those years constantly at the ready to replace any member of the primary crew and ensure the performance of the program? They, the "iron masks" in our space program, number about four-five times more than those with whose names we associate the exploration of space. Even several books wouldn't be enough to tell about what happened to them. That's why we will tell about just one—Mikhail Ivanovich Lisun, the current deputy director of the Memorial Museum of Cosmonautics and head of the Academician S. P. Korolev Memorial Home-Museum.**

**Karash:** Mikhail Ivanovich, tell us a little about how you became part of the cosmonaut corps.

**Lisun:** Generally speaking, of all the cosmonauts, I probably got to Zvezdnyy Gorodok [Star City] by the most unusual path. I had never dreamed about space, even though I had entered flight school. But as it happened, I graduated in 1956 from the engineer troops school in Kaliningrad, and in 1960, at the age of 25, I entered the Kuybyshev Engineering Academy's electrical engineering department. There I was appointed class senior officer and, in that capacity, I frequently took part in various kinds of political measures. At that time, the head of the academy noticed me. And so, just as I was finishing up my degree work, he called me in and asked about my health. Well, the first thought that popped into my head, of course, was, just where is he getting ready to

send me now, where excellent health would be needed? "I can't complain," I answered evasively. "Fine, then sit down and write a request addressed to the head of the academy. Say, 'I request that, after my studies, I be sent for subsequent service to the cosmonaut corps.'" I almost dropped the pen—what do you mean, cosmonauts? But he just told me, "Write." At the time, the government recruitment had been announced, but it had been done, as usual, secretly, and that's why no one knew anything about it. I wrote the request, and was assigned as a shift engineer to the Air Force command post at Monino. Sure enough, from there I was soon summoned to the medical commission, and later to the credentials committee, and then I was officially made one of the 22 people in the cosmonaut corps, and I arrived at the the Cosmonaut Training Center 25 November 1965.

**Karash:** Mikhail Ivanovich, the main question that probably comes up among people who know you is, How could it turn out that, with your having been in the cosmonaut corps for nearly a quarter of a century, you never got to go aloft even once? What are the main reasons for that?

**Lisun:** Well, what can I say? There are lots of reasons. The first is that our country is very wealthy and very poorly managed. NASA would never have allowed itself to entomb the professional potential of cosmonauts like we have. But why is that possible in our country, and impossible in America? Because, all this time, with the possible exception of the past year, cosmonauts who hadn't gone aloft were considered to be classified people. Their names were never revealed anywhere, and, in the early days, it was even recommended that we not even tell our fathers and mothers that we were in the cosmonaut corps. Why was tht necessary? So that then they could do whatever they wanted with us! After all, if no one knows that you are a cosmonaut and that large sums of state money have been spent on you, then no one can ask anyone about you. Now compare that with what the Americans do: they publicly announce their selection, and they do it in all the mass media and immediately assign you to whatever program. All this occurs completely in the open so that the taxpayer can constantly monitor how his money is being spent. In our country, it wasn't until last year that the magazine AVIATSIYA I KOSMONAVTIKA published the lists of all the Air Force's cosmonauts. And then, those were only the military people, but how many civilians were there?

The second reason was departmental ambitions. In fact, in 1964, when the civilian flight engineer Feoktistov went aloft, a rivalry began between the military and the civilians for the engineer's seat on the craft. NPO Energiya, the primary manufacturer of the space transport vehicles, demanded that the second crew member be a representative of that firm. Well, one can also understand their point of view. At that time, particularly in aircraft building, that practice was already well established—it was mandatory that specialists from the manufacturing plant participate in the testing of new equipment. And all the flights right up to the present day are test flights. Therefore, the Air Force made the concession and gave the flight engineer's seat to a civilian.

It must be said that we, the military flight engineers, understood right off what that meant for us. And we made a request to the then-chief of the Cosmonaut Training Center, Kamanin, that we be permitted to take extramural examinations for the aviation institute. But the chief turned us down—why, as he put it, should you do that, stick to your own field. After all, we might run short of engineers. There are so many programs! Whether he really believed that or whether he deliberately deceived us, I don't know. But the second speculation, unfortunately, is not without grounds. Indeed, if we had officially become pilots, then, in accordance with the then-existing regulations, we could lay claim to the spacecraft commander's seat, which was absolutely supposed to be occupied by an experienced pilot. And the competitors for the position of professional pilot would have been serious ones—there were among us quite a few candidates of sciences and impressive, well-educated specialists. And even back then, not all the pilots from the first two groups selected for the corps had gone aloft. Why would the leadership of Star City need another headache?

**Karash:** Mikhail Ivanovich, but why train civilian specialists practically "from scratch," when it would be much better to use already experienced and trained military flight engineers?

**Lisun:** Of course! But departmental interests, as has already been explained, are much more valuable than any money. I will tell you something else. Even though it had already become clear as early as 1965 that civilians would be flying in the second seat, both in 1967 and in 1970, military engineers were brought into the corps, and they were doomed to inactivity from the very beginning because of their appointment directly to the slot. There were, it is true, some hopes for a third seat on the craft. But, in accordance with the new regulations on cosmonauts, it would be used by the department in whose interests the tasks were being performed. And the Ministry of Defense was almost never officially this department. Later, the Intercosmos program got under way, then a woman was selected, and then the Buran cosmonauts had to be assembled, and so it went, on and on.

Perhaps, I came closest to achieving my primary goal during the programs in which the Salyut-3 and Salyut-5 stations were up (they are now known as the Almazy). Their chief designer, Chelomey, had a personal preference for dealing with servicemen. The first military engineer who went aloft to Salyut-3 was Artyukhin, who was part of the crew with Popovich. The second was Demin, who went up with Sarafanov; but they were not as lucky—they did not dock. At this point, Salyut-3 ended its existence.

Then came Salyut-5. It was also not very lucky. Volynov and Zholobov were the first ones to go up to it. They

returned earlier than planned because of Zholobov's illness. Then Zudov and Rozhdestvenskiy failed to dock. Gorbatko and Glazkov worked for the full time. And then the next crew was supposed to be Berezovoy and myself (we had been the backups for the preceding crew), but the station was literally short of 250 kilograms of fuel. That, in fact, is how, through none of my own doing, I missed my only chance to become a pilot-cosmonaut.

**Karash:** Chelomey's last station was up in 1977, but you were kept until 1989. Does that mean they were thinking of using you after all?

**Lisun:** Well, first, there was hope that the Almaz program would be resumed. Second, we worked as the mission directors [glavnyye operatory] in the Flight Control Center. There, by the way, I controlled all the Intercosmos flights. Incidentally, at one point, my incognito status was even repudiated. And who do you think did it? It is enough to make you laugh—the French. It was written in the newspapers that the mission director was a cosmonaut who had not been aloft yet, and, in the Flight Control Center, they were preparing for the visit of the then-French president, Giscard d'Estaing. For the visit of the high-ranking guest, tags with our names on them were pinned to all our jackets. And so a cameraman from French television read my name and broadcast it over the airwaves. Thus, they learned in France about the cosmonaut who hadn't been aloft, Lisun, somewhat earlier than did people in his homeland.

**Karash:** In your opinion, what circumstances ultimately play the key role in the making of the decision of who will go aloft?

**Lisun:** I do not know. Give this question to Shatalov or Leonov. Purely subjective factors are already beginning to exert a lot of influence here—who likes whom better. Why, for example, was Artyukhin the first to fly, and not Demin, even though Demin was older and more experienced and he had a candidate of sciences degree? Simply because Popovich liked Artyukhin better than he did Demin. That's all.

**Karash:** If you were being perfectly honest, as if you were all by yourself, would you say that you consider these 24 years as having been stricken out of your life?

**Lisun:** Well, how can I answer that? I cannot say that those years were fruitless. Indeed, at the risk of using pretty words, I was constantly at the leading edge of science and technology. Moreover, keep in mind the fact that the cosmonauts' training consists, as it were, of two stages—as part of the overall group and as part of a group undergoing preparation for a forthcoming flight. I was part of the latter only when I was a backup for Salyut-5. But all the rest of the time, I was in the overall group. Its job consisted of studying and testing all the innovations that appeared in our domestic space equipment. Add to that the controlling of spaceflights. So I wasn't sitting around idle.

**Karash:** Do you feel that your current work is adequate compensation for the time and efforts spent in Star City?

**Lisun:** I got what I wanted. The people in charge of the Cosmonaut Training Center asked me to remain at the center, but I wanted to make a big change in what I do and in my life in general. I wanted to be a little freer, to be more my own person, which is virtually impossible at the Cosmonaut Training Center.

**Karash:** Based on your experience in the space program and in life, what would you wish for young people who have decided to become cosmonauts?

**Lisun:** Well, I'd wish what goes without saying—good health and good luck. However, first and foremost, I would wish for our space-related departments to have a more responsible attitude toward people and money.

**Karash:** But if you could live your life over again, would you choose the very same path? If you knew that you would be in the corps for 24 years and not go aloft?

**Lisun:** Of course not! That's too big of a strain on the nerves, and, worse yet, it's an unjustified strain. To wait, to hope, and every time to find youself no better off than at the start—that's just too painful and disappointing.

**Conclusion**

While saying goodbye to me, Mikhail Ivanovich told me that he frequently gets letters from abroad (unfortunately, people abroad know our space program better than we do ourselves) in which he is asked how it is that he did not go up even once in the 24 years. Is it likely that it was because he did not justify their hopes in him? But if that were so, then why did they keep him in the corps for so long? The logic is incomprehensible to a foreigner. What can Candidate of Technical Sciences Col (Res) Lisun say in response to that question?

**Photo Caption**

1. Unidentified backup crew for Soyuz-24 [photo not reproduced]

## Original Documents From Gagarin Flight

*917Q0085 Moscow RABOCHAYA TRIBUNA in Russian 11 Apr 91 pp 1,4*

[Article by V. Belyanov, L. Moshnov, Yu. Murin, N. Sobolev, A. Stepanov, and B. Stroganov, under the rubric "Tomorrow is the Space Program Day: The Classified Documents on Gagarin's Spaceflight": "The First and the Only"; italicized introductory paragraphs are source introduction]

[Text]

*On the launch of a satellite-spacecraft*

*Decree of the Presidium of the Central Committee of the Communist Party of the USSR*

*3 April 1961*

*Strictly classified*
*Special file*

*1. The proposal of Ustinov, Rudnev, Kalmykov, Dementyev, Butoma, Moskalenko, Vershinin, Keldysh, Ivashutin, and Korolev on the launch of a satellite-spacecraft, "Vostok-3A," with a cosmonaut aboard is approved.*

*2. The plans for TASS to announce the launch of a spacecraft with a cosmonaut aboard an Earth satellite is approved, and Presidium grants the Commission for Launch the right, if necessary, to introduce updates on the results of the launch and the Commission of the Presidium of the USSR Council of Ministers for Military-Industrial Issues, the right to publicize the launch.*

**That truly historic decree and other documents, excerpts of which are published here today, are stored in the archives of the Central Committee of the Communist Party of the USSR. They are authentic.**

**It's too bad, of course, that we are becoming acquainted with such documents only now, at the threshold of the thirtieth anniversary of Yuriy Gagarin's feat. If they had been available earlier, it's possible that the nasty rumors that cast doubt upon Gagarin's launch would not have flourished. The Baikonur veterans would not have had to vindicate themselves ("Terrible Secret," published in this newspaper on March 27, 1991). But in any case we should express our great thanks to the editors of the journal IZVESTIYA TsK KPSS, who got the archival treasure and shared it with our newspaper.**

And so, the permission was given on April 3, 1961. But the irreversible countdown to launch had begun somewhat earlier. On August 19, 1960, the Vostok-1 is successfully launched. Live animals on board return safely to Earth. The task of sending a man into space is beginning to assume real proportions. On September 10, 1960, D. Ustinov, R. Malinovskiy, K. Rudnev, V. Kalmykov, P. Dementyev, B. Butoma, M. Nedelin, S. Pudenko, V. Ryabikov, M. Keldysh, S. Korolev, V. Glushko, M. Ryazanskiy, N. Pilyugin, V. Barmin, and V. Kuznetsov write a memorandum to the Central Committee of the Communist Party of the Soviet Union. In the archives it is stored under the seal "Top Secret/ Special Importance/copy 1."

The specialists note this: "Analysis of the telemetry data obtained during the Vostok-1 flight indicates that it is possible to create normal living conditions for man in spaceflight."

On October 11, 1960, also under the seal "Top secret. Special importance," the Central Committee of the Communist Party of the Soviet Union and the USSR Council of Ministers decree the following:

"1. The proposal of the USSR Council of Ministers State Committee on Defense Equipment, the USSR Council of Ministers State Committee on Radioelectronics, the USSR Ministry of Defense, the USSR Council of Ministers State Committee on Aviation Equipment, and the Academy of Sciences of the USSR, which has been examined and approved by the Commission of the Presidium of the USSR Council of Ministers for Military-Industrial Issues, on the preparation and launch of a spacecraft (the 'Vostok-3A') with a man on board in December of 1960, is approved, because it is a task of great importance...."

**Several times in the documents, the date of the launch of a man surfaces as December 1960. Why the launch was moved to April 1961 is unknown; no written instructions were found in the records. It is possible that the postponement was due to an accident at the Baikonur cosmodrome and to the death of a large group of rocket scientists and Marshall M. Nedelin.**

The following memorandum of the specialists to the Central Committee of the Communist Party of the Soviet Union appears on March 30, 1961. It reports this: "Seven launches of Vostok spacecraft were conducted: five launches of Vostok-1 and two launches of Vostok-3A." (*Successful flights of Vostok-1 without a man on board were conducted on May 15, August 19, and December 1, 1960. In two other launches, the mission was not completed. The launches of Vostok-3A craft took place on March 9 and 25, 1961, with mannequins on board.—**Ed.***)

The specialists also noted this: "The results of the work done to perfect the design of the satellite-spacecraft, the reentry systems, and the training of the cosmonauts have made it possible at present to conduct the first flight of man into space.

"Two Vostok-3A spacecraft have been prepared for this purpose. The first craft is at a test site, and the second is being prepared for launch...

"Six cosmonauts are prepared for the flight....

"The spacecraft with a man on board will be launched for one orbit around the Earth and will land in the Soviet Union on a line running through Rostov, Kuibyshev, Perm...."

There was, of course, confidence that they would be victorious. But emergency contingencies were worked out. In the memo, it clearly states this: "for the orbit chosen for the satellite spacecraft, in the event that the craft's landing system fails, the craft can descend by natural braking in the atmosphere over the course of two-seven days, with touchdown between the latitudes of 65° north and south.

"In the event of a forced landing in foreign territory or the rescue of the cosmonaut by a foreign ship, the cosmonaut has appropriate instructions.

"In addition to a 10-day supply of food and water, the cosmonaut's capsule is outfitted with a portable emergency supply of food and water that will last for three days, radio equipment, and a Peleng transmitter whose signals can be used to determine the landing site of the cosmonaut. The satellite-spacecraft is not provided with an emergency self-destruct system for the reentry vehicle....

"We consider it advisable to publish the first TASS report immediately after the satellite-spacecraft enters orbit, for the following reasons:

(a) if a rescue becomes necessary, it will facilitate rapid organization of a rescue;

(b) it precludes any foreign government declaring that the cosmonaut is a military scout.

"If the satellite-spacecraft does not enter orbit because of insufficient speed, it can land in the ocean. In that case, we also consider it advisable to publish the TASS report, so as to facilitate rescue of the cosmonaut.... In the TASS reports, it is suggested that the satellite-spacecraft be called 'Vostok'....

"We request permission to launch the first Soviet satellite-spacecraft with a man on board...."

Permission was obtained. Individuals who were direct participants in the events tell of Gagarin's flight below.

**The first cosmonaut landed near the village of Smelovka, in Saratov Oblast. An obelisk has been erected on that site. Then Gagarin was taken to Kuibyshev. That, to put it mildly, was not advertised. They simply called it "a town on the Volga." There, on April 13, 1961, Gagarin made his report at a meeting of the State Commission. The text of that meeting is preserved in the archives. Today, we present fragments of that report, supplemented by the transcripts of radio communications with the craft via the UHF and HF channels. They were conducted from the moment the cosmonaut sat in the craft and almost to landing. After launch, a tape recorder was also in operation in the capsule.**

This is what Yuriy Gagarin related.

**Just Before the Launch**

"The last pre-launch preparation took place in the morning.... In the opinion of the doctors who examined me and recorded the data for my body, my condition was good. I myself felt good, because I had relaxed and slept well beforehand.

"After that, the members of the military team helped me put on my spacesuit. They did a good job, adjusted it, pressurized it. Then they placed me in the test chair and checked to see how the suspension system laid on the spacesuit, and they checked the ventilation and communication systems. Everything worked well.

"Then there was the trip to the launch site in the bus. I, my cosmonaut friends (my replacement was German Stepanovich Titov), and the directors traveled to the launch pad. At the pad, they took me up to the capsule of the spacecraft in an elevator. I was placed in the seat by a team directed by Oleg Genrikhovich Ivanovskiy. All the connections and attachments were connected well. The testing of the equipment also went well. The communications were two-way and stable. Good communications...."

*7:12*
*Zarya 1 [Dawn 1] (Kamanin): Begin checking the spacesuit. How do you read me?*

*Kedr [Cedar]: I read you: begin checking spacesuit. I'll do it in three minutes. Now I'm busy.*

*Zarya 1 (Kamanin): Roger.*

*7:32*
*Zarya 1 (Korolev): Can you hear me? I have to transmit to you.*

*Kedr: I hear you well.*

*Zarya 1 (Korolev): Yuriy Alekseyevich, I just want to remind you that at T minus one minute, there will be about six minutes before the flight begins. So don't worry.*

*Kedr: Roger. I'm completely calm.*

*7:34*
*Zarya 1 (Popovich): Yuriy, how are things?*

*Kedr: Like they taught me (laughter).*

*Zarya 1 (Popovich): That's good, good. So long. Do you know who you're speaking to?*

*Kedr: Yes, with Landysh (laughter; P. R. Popovich was called Landysh).*

"Then hatch No. 1 was closed. I heard it close, I heard the wrenches clink. Now they begin to open the hatch again. I look, and the hatch is removed. I knew something was not in order."

*7:58*
*Zarya 1 (Korolev): Yuriy Alekseyevich, this is what happened: after the hatch was closed, it seems that one of the little contacts didn't indicate it was pressed down, so we, of course, will now remove the hatch and then reposition it. Do you read me?*

*Kedr: I read you well. The hatch is open, they're checking the indicator.*

"They announced that the countdown stood at one hour to liftoff, then at half an hour, and they recorded my physiological functions. In general, everything was proceeding normally."

*8:10*
*Zarya 1 (Korolev): Announcing T minus 50 minutes.*

*Kedr: Roger: T minus 50 minutes.*

*8:13*
*Zarya (Korolev): How do you read me? They've already started to put the hatch back on, right?*

*Kedr: I read you well. It looks like they're about finished cranking the hatch down.*

*8:14*
*Zarya 1 (Popovich): Yuriy, you're not getting bored in there, are you?*

*Kedr: If there were some music, I could stand it a little better.*

*Zarya 1 (Popovich): One minute.*

*8:15*
*Zarya 1 (Korolev): You probably hear some noise now. That's the service platform being lowered. All work is finished on the tower. How do you read me?*

*Kedr: I read you: the service platform is being lowered, but I can't hear the noise. I feel some vibrations.*

*Zarya 1 (Korolev): Roger, roger. Everything is alright.*

*Zarya 1 (Korolev): Station Zarya, this is Zarya 1. Fulfill Kedr's request. Give him some music, give him some music.*

*Zarya 1 (Popovich): Did you read that? Zarya answers: We'll try to fulfill your request. Let's have some music, or I'll get bored.*

*8:17*
*Zarya 1 (Popovich): Well, how is it? Is there music?*

*Kedr: No music yet, but I hope there'll be some soon.*

*Zarya 1 (Korolev): Well, they gave you music, right?*

*Kedr: Not yet.*

*8:19*
*Zarya 1 (Korolev): Of course, that's the way musicians are; now they're here, now they're there, but they don't do anything very fast, as the saying goes, Yuriy Alekseyevich.*

*Kedr: They gave me love songs.*

"Then they announced T minus 15 minutes. I put on my sealed gloves. I closed the helmet. T minus 5 minutes. T minus one minute and launch. Before that, you could hear the tower being taken away. There were some light blows to the structure of the rocket. The rocket seemed to rock a little."

*8:41*
*Zarya 1 (Kamanin): How do you read me?*

*Kedr: I read you well. How do you read me?*

*Zarya 1 (Kamanin): Your pulse is 64, respiration 24. Everything is going normally.*

*Kedr: Roger. That means my heart is beating.*

"Then the scavenging began. I heard the valves working. Then there was the start. The engines went to the preliminary stage. A faint noise started. Then, in the intermediate stage, the noise intensified. When the engines entered their main, primary stage, the noise intensified, but it wasn't so sharp that it deafened me or interfered with my work. The noise was approximately like the noise in an aircraft. I was prepared for much more noise. Then the rocket smoothly, lightly rose from its place. I didn't even notice when it started. Then it felt like there was a slight shiver in the structure of the rocket. The vibrations were high frequency, low amplitude.

**Flight**

"I prepared myself for ejection. I'm sitting and observing the liftoff process. I hear Sergey Pavlovich reporting."

*9:08*
*Zarya 1 (Korolev): T plus 70 (70 seconds from the beginning of the launch).*

*Kedr: I read you: 70. I feel excellent, I am continuing the flight, the g-load is increasing, all is well.*

*9:09*
*Zarya 1 (Korolev): T plus 100. How do you feel?*

*Kedr: I feel fine. How about you?*

*Zarya 1 (Korolev): Velocity and time, all normal. How do you feel?*

*Kedr: I feel fine...*

"...The g-load is increasing steadily, but it's completely manageable, as in normal airplanes. About 5 g's. At that g-load, I reported and communicated with the ground the whole time. It was somewhat difficult to talk, since all the muscles of my face were drawn. There was some strain. The g-load continued to rise, then reached its peak and began to steadily decrease. Then I felt a sharp drop in the g-load. It felt as if something had suddenly separated from the rocket. I felt something like a knock. Then the noise dropped sharply. The state of weightlessness seemed to emerge, although the g-load was about 1 at that time. Then the g-load came back and began to increase. I began to be pressed to the seat, and the noise level was substantially lower. At 150 seconds, the nose fairing separated. The process was very crisp..."

*9:10*
*Zarya 1 (Korolev): The fairing has been jettisoned, everything is normal. How do you feel?*

*Kedr: ...Nose fairing jettisoned...I see Earth...The g-load is increasing somewhat. I feel excellent, in a good mood.*

*9:11*
*Zarya 1 (Korolev): Good boy! Excellent! Everything is going well.*

*Kedr: I see the clouds. The landing site...It's beautiful, what beauty! How do you read me?*

*Zarya 1 (Korolev): We read you well, continue the flight.*

*Kedr: The flight is continuing well, the g-load is increasing, there is a slow rotation, everything is managing well, the g-load isn't bad, I feel excellent. In the window of the "vzor"* (an optical device to orient the craft in space—Ed.) *I see Earth: it is covered by clouds more and more.*

*Zarya 1 (Korolev): Everything is going normally. We read you well.*

*9:12 Kedr: The second stage has shut down.*

*Zarya 1 (Korolev): What needs to be operating, is. The last stage. Everything is normal.*

"At that time, I could see Earth in the window very well. Suddenly there were no clouds. I saw the natural folds of the terrain, a region that was a little mountainous. I could see forests, rivers, ravines. I couldn't tell exactly where it was, because I could see only a very small area in the window. I think it was the Ob or the Irtysh, but I could see it was a large river and there were islands in it. I could see everything. I reported on it."

*9:13*
*Zarya 1 (Kamanin): Everything is going well. How do you read me? How do you feel?*

*Kedr: I read you well. I feel excellent, the flight is continuing well. I see Earth, the visibility is good; I can distinguish and see everything, some space is covered by cumulus clouds, the flight continues, everything is normal....*

"The third stage shut down abruptly. The g-load increased a little, and I felt a sharp knock. After about 10 seconds, separation occurred. I felt a jolt. The craft began to rotate slowly.

"The Earth began to pass to the left and up, then to the right and down. The rotation was clearly visible in the "vzor" window. I could see the horizon, the stars, the sky. The sky was completely black, black. The magnitude of the stars and their brightness were a little clearer against that black background, and they moved across the "vzor" window and the right viewport very rapidly. I saw a very pretty horizon, and the roundness of the Earth. The horizon is a pretty, light blue. At the very surface of the Earth, a delicate light blue gradually darkens and changes into a violet hue that steadily changes to a black."

"...In my flight over the sea, its surface appeared gray, and not light blue. The surface was uneven, like sand dunes in photographs.

"I ate and drank normally, I could eat and drink. I noticed no physiological difficulties. The feeling of weightlessness was somewhat unfamiliar compared with Earth conditions. Here, you feel as if you were hanging in a horizontal position in straps.

"When I ate or drank, I released the tablet with a pencil, and it 'floated' in front of me. Then I had to write the next report. I took the tablet, but the pencil wasn't where it had been. It had flown off somewhere. An eyelet had been attached to the pencil with a screw, but apparently it needed to be glued on or screwed down more tightly. The screw had come loose, and the pencil flew off. I closed the journal and put it in my pocket. It wouldn't be any good anyway, because I had nothing to write with."

*9:26*
*Kedr: The flight is going successfully. The feeling of weightlessness is normal. I feel well. All the instruments and the entire system are functioning normally. What can you tell me?*

*Zarya 3 (Karpenko): There are no orders from 20 (Korolev), the flight continues normally.*

*9:27*
*Kedr: I read you, no orders from 20. Report your flight data. Greetings to Blondin (Senior Lieutenant Leonov, who was at the UHF radio station Zarya 3 in Yelizovo, was called Blondin).*

"The entry into the Earth's shadow was very abrupt. Up until now, I had at times observed intense illumination through the windows. I had to turn away from it or cover my face so the light wouldn't reach my eyes.

*9:49*
*Kedr: I can't hear the Earth. I'm in the shadow.*

*9:57*
*Kedr: I'm in a good mood. I am continuing the flight, I am over America.*

*Vesna [Spring] (Kadushkin): I read you.*

**Reentry**

"...In minute 56 the first command came. I immediately announced it. The orientation was good, the craft had roll rotation for some time, but very small. From the time the craft came out of shadow until the braking rocket was engaged, it turned about 30 degrees. It could have been even slightly less..."

*10:13*
*Vesna (Khoroshilov): How do you read me?*

*Kedr: I read you well. The fight is going...smooth as silk...*

*10:16*
*Vesna (Khoroshilov): The flight is going normally (answer did not follow).*

*10:18*
*Vesna (Khoroshilov): Major Gagarin, your flight is going normally (answer did not follow).*

"...Then there was the second command. I again made a report in telephone and telegraph modes. I noted the pressure in the braking rocket tank, the pressure in the attitude-control system, the readings on all the instruments, and the time the commands was transmitted, and I recorded everything on the tape recorder. I prepared

myself for reentry. I covered the right viewport. I tightened the straps, closed the sealed helmet, and switched the illumination to working illumination. Then, at precisely the appointed time, the third command was issued. As soon as the little indicator light lit up when the third command came, I began to observe the pressure in the braking rocket and the attitude-control system. It began to drop sharply from 320 atm. The instrument's needle was clearly moving in the direction of decreasing pressure. I felt the braking rocket kick in. I felt a small buzz and noise through the structure. I noted the time of activation the braking rocket. Just before that, I had set the timer to zero. The braking rocket was working well. It had kicked in quickly. The g-load began to rise a little, and then weightlessness abruptly came back. The needles for the automatic attitude-control system and the braking rocket tank jumped to zero at that moment. The braking rocket operated for exactly 40 seconds. During that period, the following occurred. As soon as the braking rocket shut off, there was a sharp jolt, and the craft began to rotate around its axis at a very high velocity. The Earth passed in the "vzor" from top right to bottom left. The rate of rotation was about 30 degrees per second, at least. I was an entire "corps de ballet": head, then feet, head, then feet, rotating rapidly. Everything was spinning around. First I see Africa (this occurred over Africa), then the horizon, then the sky. I only barely managed to hide my eyes from the Sun. I moved my feet toward the viewport, but didn't close the shade. I was interested in what was happening. I waited for the separation. There wasn't any. I knew that, according to plan, that was to occur 10-12 seconds after the braking rocket switched on. When the braking rocket shut down, all the lights on the stage separation monitoring console went out. It seemed to me that more time had passed, but there was no separation. The instrument "Reentry 1" was not lit; nor was "Prepare for ejection." There was no separation. Then the indicators on the stage separation monitoring console began to light up again: first the third command light, then the second, and then the first command light. The mobile index stood at zero. There was no separation whatsoever. The "corps de ballet" continued. I decided that something was wrong. I noted the time on the clock. About two minutes had passed, and there had been no separation. I reported on the HF channel that the braking rocket had worked normally. I estimated that all the same I would land normally, since there was 6,000 km to the Soviet Union, and the Soviet Union was 8,000 km long, which meant I would land somewhere in the Far East. The "noise" had not lifted. I reported by telephone that separation had not occurred.

"I reasoned that it was not an emergency situation. I transmitted the all-normal signal with a key. Through the "vzor" window I could see the northern coast of Africa and the Mediterranean Sea. Everything was clearly visible. The craft continued to rotate. The separation occurred at 10 hours 35 minutes—and not at 10 hours 25 minutes, as I had expected—that is, approximately 10 minutes after the braking rocket had completed its work.

"...The craft's rotation was beginning to slow, but it was about all three axes. The craft began to oscillate about 90° to the right and left. It did not complete a full rotation. There were similar oscillations about another axis, with slowing. At the time, the "vzor" window was closed with a shade. Suddenly, a bright crimson light appeared along the edges of the shade. I saw the crimson light in the small opening in the right window as well. I felt the oscillations of the craft and the burning of the coating. I don't know where the crackling was coming from: either the structure was crackling, or the thermal coating was expanding as it was heated—but it was audibly crackling. One crackling lasted about a minute. Overall, I felt that the temperature was high. Then the light became somewhat weaker in the "vzor" window. The g-load was small, about 1-1.5. Then the g-load began to steadily increase.

"...It felt as if the g-load was 10 g. There was a moment for about two-three seconds when the indicators on the instruments began to become fuzzy. Everything seemed to go gray. Again I strained to see, and that helped, as if everything went back into its place...

"...When the g-loads had fallen completely, which apparently coincided with passage through the sound barrier, I began to hear the whistling of air. In the sphere, one could distinctly hear it moving in the dense layers of the atmosphere...

"...I'm awaiting the ejection. At this time, at an altitude of approximately 7,000 meters hatch No. 1 was shot off. There was a bang, and the hatch flew off. I'm sitting and thinking, That wasn't me that was ejected, was it? Then I calmly turned my head upward, and at that moment, the firing occurred, and I was ejected. It happened quickly, and went well and without a hitch. I didn't hit anything, didn't hurt anything, everything was normal. I flew out in the seat. Then a cannon fired, and the stabilizing parachute deployed.

"I was very comfortable in the seat, as if I were in a chair. It felt as if I were rotating to the right. I immediately saw a large river. I thought, That's the Volga. There were no other large rivers in the region. Then I saw some kind of city. On the one bank was a large city, and on the other, a fairly large city. I thought something was familiar...

"...I started to descend on the main parachute. Again I was turned toward the Volga. When I was parachute training, we had jumped many times over this very site. We had flown much here. I recognized a railroad, a railroad bridge over the river, and a long spit of land extending far into the Volga. I thought that that was probably Saratov. I was landing in Saratov.

Then the reserve parachute deployed, it deployed and hung in mid air. It didn't open. Only the pack opened...."

**Landing**

"As I descended, I noticed that to my right there was a field camp on a terrace. There were many people and

machines there. It was right next to the road. The road led to Engels. Then I could see a rivulet flowing in a gully. To the left of the gully was a small house. I saw some woman there tending a calf. Well, I think, now I'm probably going to fall into that very gully, but there's nothing I can do. It feels as if everyone is looking at my pretty orange canopies. Then I see that I'm going to land in a ploughed field. Well, I think, now I'm landing. I'm going to land backwards. I tried to turn, but in that system it was hard to turn, or more precisely, you couldn't turn. Just about 30 meters above the ground, I smoothly turned my face directly toward the terrace. The breeze, I determined, was about 5-7 meters. No sooner had I thought that, when I saw the ground. I hit with my feet. The landing was very soft. The field was well ploughed, very soft, and it hadn't even dried up yet. I did not even feel the landing. I didn't even realize that I was already standing on my feet. The rear parachute fell on me, the front parachute fell in front of me. I flattened it and removed the belts. I saw that everything was intact. Then meant I was alive and well."

Yuriy Gagarin ended the story. Naturally, he was immediately pelted with questions. Many of them today seem naive, but back then, everything was a new, everything was interesting and important.

**Question:** How did the typical clock, with a clock mechanism, work—both the on-board clock and the wrist watch?

**Answer:** The clocks functioned excellently, normally, as they were set, and are still running. Pavel Romanovich Popovich has another watch.

**Question:** What sensations do you have when swallowing food and water in weightlessness? Are they different from on Earth?

**Answer:** I felt no special sensations when I swallowed water and food; it was the same. I felt no difficulties in swallowing. It's the same as on Earth: the food goes through the throat to the stomach, and so on.

**Question:** In light of the experience you have gained on the effect of lengthy weightlessness on the body, do you think it is possible for a cosmonaut who has never been aloft to remain longer in weightlessness, that is, an unconditioned cosmonaut?

**Answer:** It seems to me, from my own sensations, that flight in weightless conditions could be longer in terms of time, but an individual would have to be occupied during the flight, he would have to do some active work, and the suspension system in space would have to be freer, so that the cosmonaut would not feel like he's hanging on straps all the time. In my opinion, man can be in weightlessness for a long time. I think he could manage for days.

**The complete text of the documents concerning Yuriy Gagarin's flight will be published in the issue five of the journal IZVESITYA TsK KPSS. It will consist of memos to the Central Committee, decrees, transcripts of conversations on the UHF and HF channels, the transcript of the on-board recorder, the report of the State Commission, and answers to questions. This journal publication was prepared by V. Belyanov, L. Moshnov, Yu. Murin, N. Sobolev, A. Stepanov, and B. Stroganov.**

## Early 'Luna' Missions Recalled

*917Q0084 Moscow SELSKAYA ZHIZN in Russian 5 Apr 91 p 4*

[Article by Col. Res. A. Poluektov, under the rubric "How It Was": "A 'Hunt' for the Moon"; first two paragraphs are source introduction]

[Text] **In a few days, our nation—and with it, we hope, the entire world—will mark the thirtieth anniversary of Yu. A. Gagarin's flight into space. April 12 is an unforgettable date in the history of mankind. What preceded that day? A military tester of missile-space equipment tells us.**

**Few know of the existence of that profession. Which is not surprising, since up until recently everything that happened at the Baikonur cosmodrome was hidden from us behind a thick veil of secrecy. Meanwhile, the testers, designers, and cosmonauts approached their stellar hour. But first there was the "hunt" for the Moon.**

My memory often takes me back to Baikonur in the days of our youth, when we, specialists aged 20-25, were involved in the launch of rocket boosters with first-generation spacecraft for studying the Moon and near-lunar space. Our enthusiasm and energy brought excitement and a quest to our testing work, and the desire to succeed, no matter what. After the launch we noisily poured out onto ground zero of the red-hot launch pad, with its smell of burning rubber. If the launch was successful, we congratulated each other and S. P. Korolev. Serious and thoughtful, with an thin smile on his face, he accepted the congratulations with restraint, because there were far fewer successes than failures.

After the launch of the first artificial Earth satellites, large-scale work began at Korolev's design bureau and at Baikonur to prepare for our assault on the Moon. A rocket with a third stage (the E unit) was created on the basis of the R-7 rocket. That unit required high-density fuel, which was not available at the cosmodrome. After a decision by the State Commission, the fuel of the required quality was delivered from Baku to Tashkent on two refueling aircraft. The Baikonur airport was still being built, and so from Tashkent the fuel was delivered by railroad to the Tyuratam station, and from there, to the launch pad.

The first rocket launch took place at hot midday, September 23, 1958. The rocket lifted off successfully, but after 92 seconds of flight, it broke up and fell to Earth, disturbing the desert with several powerful explosions and huge dust clouds. The work to prepare the next rocket for launch did not go smoothly. There were frequent malfunctions. Precious time was spent eliminating them. At night,

the crew of testers would collapse from physical exhaustion and psychological stress. On one such shift, the loudspeaker announced that an American rocket with the Pioneer 1 craft had been launched to the Moon. At the end of the announcement it said, "The second stage functioned normally. The rocket is moving along the planned trajectory." Sergey Pavlovich Korolev asked that the crew of testers be assembled, and he advised them to shake off their sleepiness and fatigue, drink some strong tea, and work as hard as they could for a couple of hours more. "Don't worry that the American rocket is flying to the Moon," he concluded, "We are shooting against the rotation of the Moon, and the Americans, in the direction of rotation. That's why we will reach the Moon several hours before the Americans."

All that Korolev said was true, although he did not mention one point: the probability that we would miss the mark was much higher than for the Americans, because of the considerably higher speed at which our craft would encounter the Moon.

Soon after, they announced to us that the control system for the American rocket's third stage had failed, and the rocket, no longer on its planned trajectory, was flying toward Earth. "Now we will beat the Americans for sure," we thought. The launch of our rocket took place at exactly the appointed time—October 12. After making it through the initial leg, the rocket exploded after 100 seconds and fell to Earth like a fireworks display. In order to determine the cause of the accident, we had to gather the remaining assemblies and parts of the rocket booster. A search-and-rescue team headed by M. Novak searched them out and collected them. Collecting the remains of the rocket was not simple. The debris was scattered over a large area. And we did not know the coordinates of the site where it fell well enough, although information from the tracking stations was available. And there were other difficulties.

Here is what N. A. Lukovin, the then-deputy commander of the search-and-rescue team, has to say:

"At night we froze in tents. The dry rations were meager. Some food, huh! We were saved by wild game. Novak wasn't a bad shot, and sometimes steppe partridge appeared at our table. One time we shot several saigas, a large herd of which was crossing our path. Water was not always on hand. Sometimes it had to be trucked in from wells several kilometers away. Anyone who has been in Kazakhstan knows how difficult it is to get your bearings and travel in a semiarid land. But we didn't lose heart, and we did our job. We photographed the fragments of the rocket that we found, and then we cut them into pieces and took them to the base. The work we did everyday was reported to search headquarters by radio. Once, a communications session didn't take place: we spent several rescuing from 'captivity' a helicopter that had gotten stuck in a salt marsh."

The studies that were done enabled us to identify the cause of the failure of both rockets. In each case, resonant oscillations had arisen in the rocket in flight, which was because the rocket's center of mass had been changed when the E unit was mounted. As a result, all the bindings were broken. The search for a technical solution to eliminate the malfunction was directed by Korolev. Specialists from the design bureau and the cosmodrome participated, as did the prominent scientists M. Keldysh and A. Ishlinskiy. Naturally, they proposed various ideas. In the end, L. Voskresenskiy's suggestion was chosen, and it was distinguished by its simplicity if execution. The installation of damping devices would, according to the designer's scheme, eliminate such problems in the future. That was confirmed by the launch of the next rocket to the Moon on December 4. However, this time, there was a failure of the rocket engine after 245 seconds of flight. A failure also ended the launch of the American Pioneer 3, which took place two days after ours. As before, the booster rocket did not acquire the necessary velocity.

The next rocket tests at the Baikonur cosmodrome coincided with the greeting of the new year, 1959. They went without any problems, with the exception of one. A. Udaltsov's testers found a malfunction in a control system unit. To eliminate it, they had to solder right on the rocket. The launch of the rocket booster with a spacecraft took place on January 2. Escape velocity was reached for the first time, making interplanetary flights possible. However, we slipped in shooting for the Moon: the spacecraft missed it by 5,000-6,000 kilometers. Only two months later, the American specialists managed to place Pioneer 4 into a translunar trajectory. It missed the planet by 60,000 kilometers.

The fueling of the next rocket for launch to the Moon began with trouble. The director of the fueling-system testers sent a new guy, a young lieutenant, to the warehouse for fuel and lubricants. He was supposed to check the quality of the fuel. When the tanker arrived at the launch pad, several samples were taken and analyzed. It was found that in one tank the density of the fuel was too low.

When the reservoirs in the warehouse were checked and the soldiers involved in the work were questioned, it was found that the new lieutenant had tested only one cistern. He had become ill under the blazing sun and hid from the heat in a dugout. The soldiers, to do their work more quickly, poured fuel from the reservoirs closest to the tanker, where the density of the fuel was lower than needed. The rocket, which had been so difficult to ready for launch (it was two days late) lifted off successfully. Separation of the side units went according to schedule. However, soon after, because of a failure of a navigation instrument in the second stage, the emergency self-destruct unit of the rocket triggered. Another failure!

Then there was the launch of September 12. The rocket launched successfully, and two days later it reached the

surface of the Moon and planted the flag of our Homeland on the surface. Shortly thereafter, on October 4, 1959, the next rocket successfully entered space, and took photographs of the dark side of the Moon and transmitted them to Earth. It was a victory! The Soviet Union had confirmed its leadership in the development of space. For the first time, the Baikonur cosmodrome was awarded the Order of the Red Star for its successes.

After the successful launches of Luna-2 and Luna-3, there were two launches to the Moon in a row that ended in failure. A. Koreshkov recalls another launch that ended dramatically:

"According to the schedule, the rocket launch was to occur in the evening. About a half hour before the appointed time, all of us in a detail of officers and enlisted men climbed onto the roof of one of the entrances of the assembly-and-testing building, anticipating a colorful spectacle.

"The rocket seemed to lift off the launch pad reluctantly and with difficulty, and from amidst a furious storm of fire, smoke, and dust, several units of the rocket flew off in various directions at the same time. Above the steppe, explosions thundered one after another, accompanied by bright flashes of flame: the units had fallen in the vicinity of the launch pad and tracking station. The last unit, which had continued to fly to a low altitude, turned toward the assembly and testing frame. At that moment, it was only several hundred meters away. We stood silent, as if under a spell. That numbed state lasted only a moment. Coming to, someone shouted "It's coming toward us!" Instantly, everyone was off the roof as if they had been blown off by the wind. We found out later that the rocket unit fell short of us by a hundred meters or so and crashed into a railway bed that passed under the windows of the building. It was severely damaged by the explosion, and at one end of it, where we had just been standing on the roof, there was a deep crack that split the building all the way to the foundation."

The operations involving the lunar research were temporarily halted. Thus ended the first stage of the exploration of the planet closest to the Earth, a stage that had lasted more than a year. During that time, the technology for testing the launch vehicle that would be used to place a manned spacecraft into orbit was developed.

## Kamanin's Notes on Relationship With Korolev

*917Q0087 Moscow OGONEK in Russian No 7, 9-16 Feb 91 pp 28-31*

[Article by L. N. Kamanin. First paragraph is introductory paragraph in source.]

[Text] January 14 marks the twenty-fifth anniversary of the death of Sergey Pavlovich Korolev. We direct the readers' attention to excerpts from the diaries of N. P. Kamanin on meetings and discussions with S. P. Korolev. Publication of L. N. Kamanin.

**March 21, 1965**

Although I had no doubt that Belyayev and Leonov had survived another night in the taiga, I didn't sleep well. At six o'clock I was already on the phone with Moscow. The duty officer at Air Force headquarters added that the cosmonauts would be delivered to Perm by helicopters "in relays," with a transfer from an Mi-4 to a Mi-6... It was only about 10 AM when the message came: "The Mi-6 helicopter with cosmonauts Belyayev and Leonov landed at Perm airport."

The cosmonauts' flight from Perm to Tyura-Tam, which had been scheduled for 11 AM was delayed an hour due to Belyayev and Leonov's conversations with Brezhnev. Shortly before they left for the airport to meet the new heroes of space, a group of leading designers and flight directors (Korolev, Keldysh, Tyulin, Rudenko, Pilyugin, Barmin, Kerimov, and others) gathered at a "captain's" table with ten places. Korolev proposed a toast to cooperation: "Friends! Before us is the Moon. Let us all work together with the great goal of conquering the Moon. Do you remember how our collective worked in such a friendly manner?" I heard Barmin, who was sitting next to me, say under his breath "We worked in a friendly manner when we were all leaders...Now there's one head theoretician and one head designer...."

Yes, Barmin was right: there had not been a friendship between the members of the "space cooperation" for a long time, and this was partially Korolev's fault. He frequently made hasty decisions and was despotic in his relations with his aides. It was not without reason that the local wits called him "Scorpion-4." When Baikonur was threatened by foreign agents, the General Staff quickly warned the appropriate services of the test site with coded signals. The code "Scorpion-1" meant that foreigners were travelling on the railroad in the region of the test site, they could get the bearings of working radio stations and determine the disposition and number of launch pads. The signal "Scorpion-2" meant scouts in civil aviation aircraft were flying by. "Scorpion-3" indicated other more serious actions of foreign scouts. When any of these signals were given life at Baikonur died down for a few minutes...

Korolev had found out about "Scorpion-4" three days earlier at the most inappropriate moment. There were about two hours before the launch of Voskhod-2. The preparation of the rocket, the craft, and the crew was going according to schedule, and the situation at the launch pad was tranquil. Probably that is why the pre-launch minutes seemed especially long to us. To pass the time waiting for the launch, Korolev, Barmin, Severin, and I decided to discuss our future plans. The business conversation which was struck up was not restrained, and only rarely was it interrupted by short pauses. In one of these pauses, Severin unexpectedly turned to Barmin and asked "Do you know what they call Sergey Pavlovich at the test site?" He began to talk about the "Scorpions." ...Korolev's reaction was stormy. Lashing out he said in a frustrated voice "I was

never a fascist scorpion. 'Scorpion-4' is the stupid invention of a stupid man. I hope my friends don't start to spread such trivialities about me...." After he delivered this tirade, Sergey Pavlovich left us; an awkward silence ensued. Severin was more upset than anybody, of course, having unintentionally insulted his old friend. Korolev was like a father to Severin. Korolev highly valued his engineering talents and had great hopes for him. Severin's joke was taken very badly....

...At 17:30 we met the cosmonauts at the Tyura-Tam airport. Everyone roared with friendly laughter when Belyayev and Leonov appeared in the doors of the An-10 aircraft in flight uniforms and high boots.

**March 31**

Korolev called me and asked me to organize Belyayev and Leonov's trip to Kaluga. He said that in the first week in April he had to fly to the test site to direct the launch of the lunar rocket. The Soviet of Ministers had examined the issue of our "lunar failures" and had strongly recommended that all the head designers personally participate in the launches of rockets to the Moon. The tone in which this message was transmitted told me that Korolev did not want to break away from larger matters here in Moscow, but he had to follow The Soviet of Ministers order and again fly to Baikonur, which he had come to grow weary of. I understood Sergey Pavlovich: his health was seriously undermined, and now he had to worry about directing the entire space program.

**April 2**

I had talked one-to-one with Korolev for over an hour in his special design bureau. He told me of a possible meeting of cosmonauts and Air Force directors with Brezhnev and Kosygin. I said that if such a meeting took place, we should try to set up a "space association" at an Air Force base, order the construction of eight-10 teaching spacecraft like the Voskhod, and transform the Mission Control Center into a space scientific research testing institute. Korolev promised to support all our suggestions, saying that he would gladly work with me and Vershinin, but he was troubled by the prospect of working with Rudenko and Ponomarev. "Now you're very good, but when everything is put in your hands, you won't even approach yourself," he added half joking, half serious. I assured Sergey Pavlovich that we had avoided and would continue to avoid "difficult characters," some of the high-ranking leaders of the Air Force, and we would do everything so that the interest of the matter wouldn't suffer.

Then we agreed on three possible crews for the next flight: Volynov and Katys, Beregovoy and Demin, and Shatalov and Artyukhin. I thought that the main crew should be the Volynov crew; however, his candidacy was still being disputed. Marshall Rudenko had turned the high command toward Beregovoy, but I would do everything possible for Volynov to fly. Volynov had been in flight training for five years and had been a back-up four times. Korolev agreed with me that the tradition of preparing back-ups was very useful, it should be fostered and not broken, as Rudenko would have it (Beregovoy, naturally, was a strong candidate, but we no longer saw him in the role of a back-up).

The last issue in our discussion was more delicate. I remember well all of our troubles during the Tereshkova flight. There were many disruptions, and when Tereshkova finally landed, Korolev said: "If I ever get involved with broads again...." And indeed the matter had to do with "broads." I suggested to Korolev that he prepare to repeat Belyayev and Leonov's flight with a female in the crew and named a possible crew for this flight: Ponomarev and Solovyeva. I was motivated to make this suggestion because a space walk by a woman, with a wide range of studies, and possibly with the use of autonomous means of movement in space would have no less response from the world than the flight of Voskhod-2. Having made my suggestion, I looked at Korolev. At first he darkened, his eyes dimmed, and it seemed as if he was containing himself with difficult, so as not to say anything caustic. When he realized the full meaning of my proposed experiment, he began to smile, and then he said with a laugh, "I have to think about this, you old mouse...." We agreed that Sergey Pavlovich would seriously consider my proposal. I asked him not to rush in making a decision.

**April 12**

In accordance with Cosmonautics Day yesterday, the Mission Control Center held a meeting of the cosmonauts with Korolev, Glushko, and other chief designers. I was not at this meeting, but according to what General Kuznetsov said, it went well. Kuznetsov also said that he noticed a certain reconciliation between Korolev and Glushko. I doubted that; they still were quarreling a lot and they had been avoiding contact with each other for too long and too stubbornly. But if there was a reconciliation it was only because of their common interest in the matter.

**April 13**

Yesterday I went to the Palace of Congresses for a celebratory gathering on Cosmonautics Day. For the first time in the presidium there was a meeting of not only Vershinin and the cosmonauts, but also three representatives of the Air Force: Rudenko, Rytov, and Kamanin. Unfortunately, Korolev and other head spacecraft designers were not there. I mentioned this to the Secretary of the Ministry of Culture of the party, Yegorychev. He said that this issue had been raised numerous times in the Central Committee, but until a decision was reached, nothing would change in the "game of secrecy." I spoke with Keldysh about the female version of the space walk flight. Keldysh remembered Ponomarev and Solovyeva well, he immediately appreciated it and promised to support my proposal. Korolev, Vershinin, and Keldysh had shown a definite interest in the flight

with a female in the crew, but until Korolev took to this idea "preparing" the directors would never be complete.

**April 14**

I just spoke to Korolev on the telephone. I gave him three variants of a crew for a long flight with an experiment on artificial gravity and for a flight with a walk in open space. Korolev basically agreed with the proposed variants, but he did not restrain himself in indicating the "boring character" of Ponomarev. I had heard this expressed about Ponomarev repeatedly by Gagarin and other cosmonauts. I had no doubt that they were all against the female in the crew, nevertheless in two or three days I would give the official order for the preparation of Ponomarev and Solovyeva for flight.

Korolev expressed the wish to include in the crew an appropriate doctor for the Institute of the Ministry of Health for an experiment with artificial gravity. I did not argue with Sergey Pavlovich about this, but at our next meeting I proposed that instead of sending a doctor and experimental animals into space again, we should install an additional engine on the craft to make maneuvers to change orbit. I had already spoken of this to Vershinin, he also was in favor of this correction to the schedule of space flights, and told me to try to convince Korolev of its expediency.

**April 23**

Today the launch of the retranslation satellite, Molniye, was scheduled. We had made several attempts to create satellites for retranslation of television broadcasts, but they were all unsuccessful. In the previous launch Molniye was placed in orbit, but its antennas did not deploy. The experiment was ruined again. Unfortunately, we had had too many disappointing disruptions in the implementation of our schedule of unmanned interplanetary and orbital probes, and these disruptions were not random: they were in the very system of development, testing, and launch of unmanned craft, which had all been farmed out to Korolev. The work which he did on this was not seriously monitored. He needed help, especially in the organization of Earth-based testing of the space equipment. Korolev could get this help from the Air Force, but due to departmental barriers and the caustic nature of the directors of the Ministry of Defense, they were not attracted to testing unmanned space systems and devices for us. We helped Korolev only with the creation and preparation of the flights of manned craft, but even here we were not doing everything possible; the absence of "unified management in space" hurt the situation a great deal.

**August 16**

Korolev called me and expressed his dissatisfaction with the fact that Chelomey was beginning to build a spacecraft to fly around the Moon. A long time ago Korolev had expressed the idea of a monopoly on the construction of spacecraft in his special design bureau, and turned to find support on this issue from the military. A resolution of the Central Committee of the Communist Party of the Soviet Union and the Soviet of Ministers commanded Chelomey to build twelve craft to fly around the Moon before the beginning of the second quarter of 1967. For more than a year Special Design Bureau-52, which was headed by Chelomey, had been working on fulfilling this assignment, and now it would be unreasonable to switch it to another executor. To develop cosmonautics it was useful for spacecraft to created not by one but several firms.

**August 20**

I spoke with Korolev by phone, and he complained that he did not feel well because of his low blood pressure (100 over 60). I advised Sergey Pavlovich to go home and rest, perhaps lie down.... I discussed with him the candidates for the role of commanders of the first two Soyuz craft. Korolev agreed with my proposals (I named Gagarin, Nikolayev, Bykovskiy, and Komarov) and said that he considered Nikolayev and Bykovskiy the most likely participants for the first manned flight around the Moon. I, in turn, supported Sergey Pavlovich's proposal that the second member of the Soyuz crew to dock in space should be an engineer. I named Demin and Artyukhin as candidate engineers from the Air Force. Korolev did not object, but he advanced his own candidate: Feoktistov. We agreed to renew the discussion of the proposed crew compositions for the Soyuz flights in a personal meeting.

**September 1**

Korolev and I agreed to meet today at Special Design Bureau-1. Five minutes before the appointed time I was already there in the waiting room. Usually Sergey Pavlovich met me himself, but this time my arrival caused his secretary some confusion. She asked me to "wait a minute" and closed the doors of the office, but quickly returned and invited me to enter. Korolev looked a little rumpled. I understood that he had been resting. Sergey Pavlovich had been suffering from headaches and low blood pressure for a long time. When I asked him how he was, he answered: "I was just on vacation, I don't feel too bad. I've been rushing around between the office and the polyclinic in Granovsk...." During our discussion Korolev returned to his illnesses several times, he even turned to me with these words: "Apparently, I can no longer be the technical director of flights, What do you think of Shabarov was a candidate? Can he replace me? Maybe the Air Force will pick their own technical director?" I answered that now, in my opinion, no one could completely replace him in this post, but it was necessary to replace him; he had to think about his health and concentrate all his efforts on the most important thing. Naturally, Shabarov was a suitable candidate of the role of technical director of flights, but in order to completely replace Korolev he would have to have his talent and endure a new "dawn of the space age."

I told Korolev that we had begun to prepare Gagarin, Nikolayev, Bykovskiy, Komarov, Kolodin, Artyukhin,

and Matinenko for the Soyuz flight. Sergey Pavlovich retained his right to add to this group of cosmonauts several engineers from Special Design Bureau-1. One had to recognize that he was prudent about the preparation of his engineers for future flights; Feoktistov's experience in the Voskhod flight had been very useful in improving manned craft.

We discussed candidates for the next flight: the main crew would be Volynov and Katys, the back-up crew, Beregovoy and Demin. Korolev thought that this flight, which was scheduled for 10-15 days could be done in November, but I persuaded him that it could not occur earlier than January of the next year (the crew was ready to fly in October, but the craft would not be prepared for flight quickly). Sergey Pavlovich agreed with my proposal to prolong the training of the female crew member for a flight with a space walk. I expressed my firm conviction that Ponomarev and Solovyeva were capable of a ten-day flight with the entry of the co-pilot in open space.

In the final part of our conversation we addressed the "Moon problem." We decided that it would be expedient in September to have a conference with Korolev and Chelomey's reports on the course of preparation for a flight around the Moon and the landing of a crew on its surface. Having approved our plan to select six-eight cosmonauts for special training for the lunar program, Sergey Pavlovich told me with visible satisfaction about the state of the N-1 rocket. It was his baby, and it should be ready in metal by the end of 1965. The N-1 booster would be capable of lifting 90 tons into orbit, and after the installation of booster engines it would have a 130 ton payload. What type of load this would be was as yet unclear. Korolev thought that the payload for the first N-1 rockets could be a "handful" of Soyuz craft. The first 90-ton spacecraft was to be built at the beginning of 1966.

**September 18**

This morning I called Korolev to remind him of his promise to meet with a group of independent designers participating in the development of a lunar rover. Korolev answered rather dryly, "Nikolay Petrovich, today there are many people here and I cannot talk to all of you who want to talk to me. I'll call in an hour, the conversation will be unpleasant..." Again something had put Sergey Pavlovich out of equilibrium...

Yesterday I sent Korolev a letter with the Air Force's proposals for the Voskhod spacecraft program. I have no doubt that it had gotten a hostile reaction, and there would be a lot of noise again. But noise is noise, and business is business; Korolev, unfortunately, frequently made noise to no avail.

**September 20**

On Saturday, at the end of the work day, Korolev conducted the "unpleasant" conversation he had promised. Sergey Pavlovich was disturbed by my letter, in which, instead of a 15-day flight, one of the two-man Voskhods with medical assignments, we proposed a flight with one cosmonaut for 20-25 days with the completion of a number of military goals. Korolev told me approximately the following: "I have always had good relations with the Air Force, and personally with you.... It seems to me that before you undertake something important you should consult me. Now I am in a foolish situation, the MOM [expansion not given] and the Military-Industrial Commission are going to call me and for spite ask me if I will alter a craft under the Air Force program. I know that you are the initiator of this matter, you forced Vershinin to sign this letter; the old man signs everything that you propose to him. I can't work like that. We can prepare cosmonauts ourselves, without the help of the Air Force. We will manage without your space center and we will prepare not only engineers and doctors for the next flights, but also craft commanders.

I tried to calm Sergey Pavlovich, and I said that we, in essence, were repeating his proposals, which he had brought up with us twice this year, and that in our letter, which formally answered the August resolution of the Military-Industrial Commission, we were not talking about upcoming flights on the Voskhods. Someone had roused Korolev so much that he did not understand the entire value of the Air Force proposals for his special design bureau. He could support our plans in principle to obtain from the Ministry of Defense a special order for the construction of new spacecraft.

Korolev's threats that he would reject the "services" of Mission Control Center had been expressed before but I was completely convinced that no one supported his plans to have "everything his way" for space flights. The preparation of cosmonauts was too complex and expensive to be done privately. We already had official letters from the President of the USSR Academy of Sciences and the Minister of Health requesting the preparation of teams of scientists and doctors for space flights at the Air Force Mission Control Center. I think that it was no accident that these two documents were directed against Korolev's tendency toward autonomy.

I did not attach great value to this conversation, it was not the first or last skirmish between us. I did not want to and do not want to damage my relation with Korolev, but frequently Sergey Pavlovich himself behaved so abruptly and hastily that he gradually drove away even those who valued and loved this intelligent but capricious man with despotic manners. Korolev, in essence, is a loner, he has few real friends, and he himself is to blame for this more than anything else. And yet despite that I will try to do everything that depends on me to improve the interrelations between me and Korolev.

**November 1**

Day after day, month after month we inexorably approach old age, and the weight of the years we have lived becomes heavier and heavier. But it seems early: I

want to be an active organizer of manned flights to the Moon. Probably a flight around the Moon will occur in 1967, and after two or three years we will be able to land and live on our permanent satellite. I have always believed that the first man to set foot on the surface of the Moon will be a Soviet cosmonaut. But now I'm not as certain as I used to be. The Americans, who have made grandiose efforts to conquer space, have somehow gotten ahead of us. We are spending less on space, and what is more important, we are not using these funds wisely.

The cosmonauts and I have written a letter to the First Secretary of the Central Committee of the Communist Party of the Soviet Union about our drawbacks in the preparation of space flights. Several days ago, Yuriy Gagarin personally handed it to one of Brezhnev's aides. A week passed, but Brezhnev has not even acquainted himself with the contents of the letter. He is spending time on the matters of Algeria, Zambia, and other "urgent" problems, but doesn't take one hour to interest himself in the reasons we are behind in space. Our hopes for Marshall Grechko are also minimal: he does not oppose Malinovskiy's position. Our "space efforts" continue to be divided, poorly managed.

Today I planned to meet with Korolev to try to refine the lengths and missions for future flights. But Sergey Pavlovich flew off on an assignment, he apparently has long forgotten his promise to make the next manned flight in the middle of November. Moreover, I found out that Korolev planned to reject the earlier planned experiment to create artificial gravity in orbit, and to halt the construction of craft capable of going into open space. A month ago there were hopes to clarify our plans, but now Korolev's efforts have completely obscured everything, and it is as if a dense fog is spreading over the near future.

Industry, the Academy of Sciences, and the Ministry of Defense are completely dependent on Korolev's caprices. Everyone "looks him in the face" and waits for genial solutions, and he himself, in essence, is marking time, creating a disturbance for the other chief designers: Glushko, Chelomey, Voronin, Severin, Tkachev. In this serious situation sometimes one loses heart.... But we can't retreat: before the end of the year the cosmonauts and I will put up a decisive fight with everyone who is now slowing our advancement into space, primarily Malinovskiy, Smirnov, and Krylov. We must do everything possible to break down this "wall."

I spoke by telephone with Tsybin and Ivanovskiy. Both of them confirmed Korolev's plan to remove the artificial gravity experiment (we spent a half year on its development) and to prepare for a flight 15-20 days in length. I advised Sergey Pavlovich in March to prepare such a flight, but then he did not agree with my proposal.

**November 24**

I talked with Korolev for more than an hour. We had not seen each other for almost three months. In our six years of joint work this has been the longest interval between meetings. It is true that we frequently talk on the phone, and toss papers to each other, but this was a small matter.

Sergey Pavlovich looked fatigued and was very troubled by the fact that a series of thirty Soyuz craft under construction are going into the unfinished production of incomplete Voskhods. Korolev told me that the people at the ministry had tried to "beat" him, but he was able to prove that the production of spacecraft had been delayed by the factory which produced parts for another factory. This was the first time I had seen this man in a state of some confusion and even dismay. "They're squeezing everything, come on, come on,... And what can I do, if there are no deliveries from the 'cooperation'? So I give them a hand...." he admitted to me bitterly.

Sergey Pavlovich also complained about Glushko, who at the meeting of the Military-Industrial Commission had given a sharp criticism of the activity of his special design bureau. The criticism, in Korolev's words, was not friendly, but sought to force him into a corner. "Glushko thinks," said Korolev, "that he is the chief successor and descendant of Tsiolkovskiy, and we are only making tin cans..."

A two-time Hero of Socialist Labor, Academician Valentin Petrovich Glushko was an intelligent very tactful man, and I couldn't believe that he had constructed intrigues against Korolev. It was more likely that Sergey Pavlovich had taken his critical comments poorly. The quarrel of two of our most talented scientists hurt the matter a great deal. It would be necessary to try to resurrect their former friendship.

At the end of the conversation Korolev again stated that at the Soviet of Defense and everywhere where the problems of cosmonautics would be examined he would support the proposal of the Air Force and the cosmonauts. Korolev repeated his favorite saying, "Born to crawl, he cannot fly," again and again.

In our years of joint work I argued heatedly with Korolev more than once, but after a thorough discussion of our extreme positions we almost always found a way to come closer. Today's meeting, like no other, was peaceful and friendly.

**December 22**

Today I had a very unpleasant telephone conversation with Korolev. The reason for the discussion was the complaint of one of the civilian candidates for the Voskhod-3 crew, G. P. Katys, whom the directors of the Mission Control Center had removed from flight training. In exasperation Korolev had brought down on me completely unsubstantiated allegations: "The Air Force is continuing its policy of removing civilian cosmonauts from flights. That's the way it was in the preparation for the Voskhod-1 flight, and that's how it's continuing now. I'm tired of the behavior of the military;

I will place the issue of forming a civilian crew for Voskhod-3 before the State Commission."

I was disturbed by Korolev's statement, but tried to tell him as calmly as possible: "Katys was not removed from the Mission Control Center, he was only told that now the probability of including him in the crew of Voskhod-3 was substantially lower than in November, since Volynov and Gorbatko were much better prepared for a 20-day flight. By the way, you agreed to this decision three weeks ago. Your threats to reject our cosmonauts are not new and do not do you any honor. Speak out however you want. We have also grown tired of our constant caprices and hysterics. In answer I heard, "Well, we will assume that we have agreed upon nothing. Goodbye."

Korolev frequently stooped to trivialities, harassed and irritated people, interfered with details and neglected the key thing: time and the quality of preparation of the spacecraft. He spread himself too thin and tried to keep everything under his control; this explained his continual conflicts with Glushko, Pilyugin, Voronin, Kosberg and other chief designers. Korolev even tried to influence the activity of the Air Force. In a number of cases we have met and will meet him halfway, but we will not let him unceremoniously interfere with our affairs.

**December 24**

Yesterday I visited Korolev at Special Design Bureau-1 to celebrate the sixtieth birthday of P.V. Tsybin. More than 70 people presented speeches, naturally wishing him a hundred times more than the best that one talented person could do in his whole life. It was good that Pavel Vladimirovich Tsybin is a modest and sensible man: I'm sure this flow of acclaim will not spoil him.

Yuriy Gagarin and Aleksey Leonov saluted Tsybin in the name of the cosmonauts, and I saluted him in the name of the Military Council of the Air Force. Leonov's salute was very successful. Speaking to Tsybin, who was presented two dogs by Academician V.V. Pasrin who had spoken earlier, Leonov said, "We are not presenting you with dogs. We are presenting you our hearts, our able hands, and if required, our very lives.... For us, the cosmonauts, life is flights into space!"

Korolev conducted the celebration excellently. He restrained himself with me, as if there had been no unpleasant conversation between us. He is an intelligent, very intelligent human begin. It is only a pity that his impulsive character gets in his way.

**January 5, 1966**

Yesterday I spoke with Gagarin, Titov, Popovich, Nikolayev, Tereshkova, Bykovskiy, Komarov, and Belyayev. All the cosmonauts are pessimistic as never before. Their limitless faith in Korolev has been dealt a serious blow by Korolev himself: Sergey Pavlovich came to the center, met with the cosmonauts, but could not tell them anything definite about the next flight. The cosmonauts' moods was also affected by the fact that it was three months ago when their letter was delivered to Brezhnev, but in this time no one has even discussed with them the contents of the letter. The complete indifference of the high command to the problems of cosmonautics can only be explained by the confusion and fear of discussing the entire series of our failures.

**January 9**

...Several days ago Korolev was in the hospital for two-three weeks: before him is the prospect of an operation to remove a tumor in the duodenum. According to preliminary data, the operation is not serious but rather unpleasant.

**January 17**

I just returned from the Palace of Congresses, and stood there in the honor guard at the coffin of Sergey Pavlovich Korolev. It has been three days since he died, and I still don't want to believe that he is no longer among the living....

On Friday I spent the entire day at the Mission Control Center, advising the cosmonauts and the directors of the center about the composition of the crews for the three Voskhods and three Soyuzes. The decision was made that in the next flight the main crew would be Volynov and Shonin, with the back-up crew of Beregovoy and Shatalov. I ordered the training of women for flights lasting 15-20 days to begin again starting January 17. The main crew with a female will be Ponomarev and Solovyeva, and the back-ups will be Sergeychik and Pitskhelauri. I commissioned Tereshkova to direct the training of female crew members.

I went directly home from the Center, and Kuznetsov and Gagarin intended to go to Special Design Bureau-1 after me.

About seven o'clock in the evening the phone rang, and General Kuznetsov told me the terrible news: Sergey Pavlovich had died....

Like an avalanche, this terrible misfortune came down upon us rapidly and unexpectedly. The country has lost one of its most outstanding sons, and our cosmonautics had been orphaned. Korolev was the main author and organizer of all our space successes. His personal contributions to cosmonautics, the Soviet people, and all of humanity are limitless. He could have done much more, but he left us when his talent was in bloom.

I do not think that Korolev's death will slow our progress toward the conquest of space. We have created powerful scientific and industrial collectives, and they are capable of successfully resolving the most complex problems. During the last two-three years Korolev allowed many errors, he didn't use the advice and initiative of his aides and friends, and without wanting to, sometimes slowed

matters (this was the case with the TsF-16 centrifuge, with Voskhod-3 and Soyuz). Korolev's first deputy, Vasiliy Pavlovich Mishin, was named the director of Special Design Bureau-1. Naturally, Mishin is not Korolev, it is difficult to replace Sergey Pavlovich with one man. Only the general friendly work of the collectives can to some extent fill the vast gap.

All three days the cosmonauts in turn stood by Nina Ivanova. She is, poor thing, worn out. Today the cosmonauts have stood in the honor guard at the coffin several times. At nine o'clock in the evening they will be present for the cremation of the body. Petrovskiy himself, the Minister of Health, operated on Korolev. Sergey Pavlovich entered the hospital on his own feet as they say, and the doctors assured him that the operation would last a few minutes, and actually it lasted more than five hours: his weakened heart could not withstand this load and paralysis set in.

**January 19**

Yesterday Sergey Pavlovich was interred in Red Square. The urn with his ashes was carried from the House of Unions by members of the State Commission, Smirnov, Keldysh, Tyulin, Gagarin, and others, and the cosmonauts carried it from the Historical Museum to Red Square. After a gathering, Brezhnev, Podgornyy and other leaders lifted the urn and placed it in the Kremlin Wall. L. V. Smirnov placed the urn in the niche, which was then covered with a marble plaque with the inscription

KOROLEV Sergey Pavlovich 20.12.1906-14.01.1966

Korolev occupied a place in the Kremlin Wall next to S. V. Kurashov (USSR Minister of Health). I was irritated by the fact that they were neighbors: it unnecessarily reminded me of the great guilt of our medicine in the premature death of Sergey Pavlovich.

All of the orators at the funeral gathering especially solicitously stressed the thought that Korolev was a great scientist, but not the chief director of space studies, that there we had many like Korolev. This is not true. I know that thousands of staff and dozens of chief designers worked along with Korolev, but it was he who was the Chief Designer of spacecraft, and not only in post, but in essence as well.

I will always place unlimited value on Korolev's talent. I knew features of his character which were not the best, but they cannot hide the magnitude of the figure of our Chief Designer. His name should be before the names of all our cosmonauts. I am deeply convinced that it will be.

## Titov Comments on Anniversary of Vostok-2 Flight

*LD0608092391 Moscow TASS in English 0750 GMT 6 Aug 91*

[By Rena Kuznetsova]

[Text] Moscow August 6 TASS—"The tendency towards cooperation in space research and exploration for peaceful purposes that became pronounced in recent years will develop further in major global projects," says General German Titov, who was second in space after Yuriy Gagarin's trail-blazing flight.

August 6 marks the thirtieth anniversary since the launch of the Vostok-2 spaceship piloted by Titov.

"The world's first cosmonaut dreamed of making space serve man's vital interests, peace and progress on Earth," Titov told TASS. "We intend to create production complexes in space to carry out an extensive program in the interests of different branches of the national economy".

"The international space year, scheduled by the U.N. General Assembly for 1992, opens prospects for the further development of international cooperation in space, which will enable space research to be oriented towards mankind's needs, towards the solution of global problems," the Soviet cosmonautics veteran said.

"Discussions are already underway of specific programs for the use of space facilities to study natural resources, protect the environment and perfect space technologies".

## Comments on Facilities, Problems at Baykonur, Map of Cosmodrome

*917Q0079 Moscow ARGUMENTY I FAKTY in Russian No 15, Apr 91 p 6*

[Article by ARGUMENTY I FAKTY correspondent I. Kabak: "The Cosmodrome Without the Halo: Baykonur Covers 7,360 Square Kilometers"; first paragraph is source introduction]

[Text] **Oh, the epithets journalists have come up with when talking about Baykonur! But meanwhile, the cosmodrome is a national economic complex (although a unique one) which is now experiencing the very same difficulties as the most ordinary factory: problems with financing, supply, deliveries, and innumerable shortages.**

And so, just what is the cosmodrome like today?

The cosmodrome covers 7,360 square kilometers. There are roads and railway lines. There are two airfields, including one for Buran. The city of Leninsk has a population of almost 100,000 people. Located here are a branch of MAI [Moscow Aviation Institute], a communications technical school, 10 general-education schools, two palaces of culture, a movie theater, a stadium, restaurants, bars, four hospitals, a park, playing fields, a swimming pool, and tennis courts.

The cosmodrome consists of unique structures.

The Energiya launch pad goes down five stories. On it are two service towers 64 meters high and two diverters (lightning rods) 225 meters high.

The Buran assembly complex, with an area of 17,000 square meters and a height of 60 meters, is a covered stadium with a constant microclimate and temperature.

Daily, 300 loaded railroad cars arrive at the cosmodrome. The amount of bread baked is 70 tons. The 180,000 cubic meters of water are used.

Unfortunately, no one has yet calculated precisely how much was spent to create a space complex practically in the middle of the desert. And, unfortunately, no one has yet calculated, even approximately, what we are getting from the cosmodrome and what we might be able to get.

N. Zelenshchikov, NPO Energiya deputy general designer says this: "A paradoxical situation has arisen: we create space complexes, successfully solve the most complicated technical and production problems, and send unique vehicles into space, and, in the process, we ourselves play the role of customers. We have prepared more than 600 of the most diverse technologies, and have sent their descriptions around to the departments and enterprises—and we've gotten no response."

F. Chilyakov, fitter in the Energiya Assembly and Testing Building: "Nobody can complain about the conditions at work. Although the prices in the dining hall are astronomical.

"But...my wife and I have been living in a hotel for six years. We cook on a hotplate. As far as foodstuffs go, it is a mess, we don't have time to redeem coupons, and we have no gardens, hence, no potatoes and no vegetables. There is no bath. It is cold in our room. I'd say the rumors about Baykonur being a paradise have been greatly exaggerated."

## Commentary on History, Achievements of U.S. Space Shuttle

*917Q0081 Moscow PRAVDA in Russian 16 Mar 91 Second Edition p 5*

[Article by V. Bobylev, head of the Foreign Space Technology Sector of the Central Machine Building Scientific Research Center, under the rubric "An Authority's Opinion": "The Shuttles' Space Speedometer"; source introduction follows letter from reader Pavel Sosykin]

[Text] *In the 5 January 1991, edition of your newspaper, I read a brief note that said "Robert will move to the Atlantis ship." Could you elaborate in more detail and in everyday language on the Space Shuttle program and tell about the people associated with it and about interesting episodes and scientific achievements?*


**Figure 1. The Baykonur Cosmodrome**

Key: 1. Yubileynyy Airfield—2. Proton launch areas—3. Observation posts—4. Energiya launch area—5. Energiya-Buran launch area—6. Vostok launch area—7. Soyuz launch area—8. Zenit launch area—9. Vega area—10. KAZ—11. Saturn area—12. Kraynyy Airfield—13. Tyura-Tam—14. Leninsk—15. Syr-Darya River

*Pavel Sosykin, Verkhniy Tagil, Sverdlovsk Oblast.*

**V. Bobylev, head of the Foreign Space Technology Sector of the Central Machine Building Scientific Research Institute, at the request of the editorial staff, responds to the reader.**

The operation of the American Space Shuttle reusable space system can be divided into two periods. The start of the first was marked by the successful mission of astronauts John Young and Robert Crippen in near-Earth orbit aboard the Columbia ship; the mission began on 12 April 1981. The end of the period was marked by the disaster involving another orbiter, Challenger, on 28 January 1986. Challenger and other components of the space system exploded 74 seconds into the flight at an altitude of around 14 kilometers. The seven crew members, including two women, perished literally before the eyes of their relatives, friends and acquaintances, who were on the viewing stands of the space launch facility at Cape Canaveral.

In the first period, right up to the final, tragic 25th launch, the feasibility and high level of efficiency of the basic concepts, designs and administrative decisions that underlie the program had been proven in practice. For the first time in the history of spaceflight, operations such as the repair or return of earlier launched satellites to the ground for reconditioning and re-use were performed in orbit. A special device was developed for the independent movement of a person in open space, which is extremely important for the in-orbit servicing of satellites and the construction of large space structures in the future. The use of an on-board manipulator arm laid the foundation for space robotics.

After the resumption of shuttle launches, the United States began to gradually put new models of the traditional type of launch vehicles into service. The reusable ships' monopoly ended, and, since then, they have been used to launch the more costly space vehicles. Nearing completion is the construction of a new reusable orbiter, the fifth in the series, which has been given the name Endeavor and which was ordered by NASA in 1987 to replace Challenger. Incidentally, all the orbiters are virtually identical. It should be noted that the level of flight safety became higher after the Challenger tragedy; however, the operation of the system has become considerably more complicated. For example, the preflight preparation period was doubled, and the total number of approval stamps on documents testifying to the worthiness of the transport system's components is now nearly 350,000. In all, in the second period of the program, 13 missions have been flown to date. The launch in May 1989 of the Magellan interplanetary craft for a radar study of Venus can be considered to be one of the more significant missions. In October of that same year, the shuttle was used to dispatch another interplanetary craft, Galileo, this time toward Jupiter. Also launched in October of last year [1990] was the Ulysses craft, which is to study the sun's polar regions, which are unobservable from Earth. However, the main event has been the launch of a unique space observatory—the Hubble Telescope, which makes it possible to expand the radius of the Universe accessible for observation to 140 billion light years from 20. President Bush called the Hubble Space Telescope the most complex artificial satellite in the history of mankind. In January of last year, one of the shuttles delivered to the ground from space an experimental platform [LDEF] for determining the nature of the long-term effect of space on samples of various materials and even plant seeds, all of which had been in space since April of 1984.

In December of last year, the plans for Space Shuttle system missions for the years 1991-1993 were published. Over the course of this year, seven launches will be performed, and 27 flights in all have been planned for the three years.

In conclusion, I would like to point out that, despite the difficult periods in its development, the Space Shuttle program continues to be the most important component in the U.S. national space program.

## Indian Satellite To Be Launched by USSR

*LD0608162191 Moscow TASS in English 1609 GMT 6 Aug 91*

[Text] Moscow August 6 TASS—An Indian artificial earth satellite is to be launched by a "Vostok" booster rocket from Baykonur Cosmodrome on August 29, the USSR Glavkosmos (the main space administration) announced.

The launching is envisaged by a commercial agreement between the two countries. Soviet and Indian specialists now are conducting preparations for the launching of "IRS-1B" satellite.

## Indian Remote Sensing Satellite To Be Launched 29 Aug

*LD1808121291 Moscow Radio Moscow World Service in English 0710 GMT 18 Aug 91*

[Excerpt] Soviet-Indian cooperation in space research is developing successfully. A Soviet rocket is to lift an Indian satellite on 29 August. The IRS-1B, to be orbited by a Vostok booster, is designed for remote sensing of the earth and the Indian Ocean. Soviet and Indian experts are currently preparing it for the blast-off from Baykonur cosmodrome.

Under a commercial agreement signed in Moscow at the beginning of the year, the Soviet Union is to launch two more Indian satellites in the next few years. The first, the IRS-1C, is to be a new generation earth and ocean resources probe based on the latest achievements in science and technology; it will be orbited in 1994. The other, the (Gramsat) communication satellite, will be blasted off later. [passage omitted]

## Preparations For Launch of Indian Satellite 29 Aug

*LD2808085491 Moscow TASS in English 0816 GMT 28 Aug 91*

[By TASS correspondent Rena Kuzetsova]

[Text] Moscow August 28 TASS—The Indian IRS-1B satellite will be put into orbit by a Soviet Vostok booster rocket on Thursday [29 August], a Soviet Glavkosmos spokesman told TASS.

Soviet and Indian specialists at the Baykonur launch site are completing preparations. Glavkosmos head Alexandr Dunayev has been appointed chairman of the state commission. The joint experiment is being carried out on a commercial basis.

The satellite is expected to sound the earth's surface and the ocean in the interest of the Indian economy.

## USSR Launches Indian IRS-1B Satellite

*LD2908152991 Moscow TASS in English 1421 GMT 29 Aug 91*

[Text] Moscow August 29 TASS—The Indian IRS-1B space satellite was put to orbit today by a Soviet Vostok booster rocket.

This is the second Indian satellite launched from the Baykonur launch site. The satellite is aimed to receive operative information about India's natural resources with the help of optic and electronic equipment.

Indian scientists and specialists have created the satellite and tested it at the launch site.

The satellite has been put to orbit with the following parameters:

—Maximum distance from the Earth's surface—924 kilometers,

—Minimum distance from the Earth's surface—869 kilometers,

—Rotation period—102.9 minutes,

—Orbital inclination—99.25 degrees.

Equipment is functioning normally.

The satellite is being controlled from the mission control center in Moscow region and the Indian mission control center in Bangalore.

## Coup Leaders Ordered U.S. Space Specialists Out of USSR

*917Q0180 Moscow IZVESTIYA in Russian 29 Aug 91 p 4*

[Article by B. Konovalov, IZVESTIYA scientific observer: "The Attempt to Torpedo Soviet-American Cooperation Did Not Succeed", first paragraph is source introduction]

[Text] Data has started to come in from the American instrument installed on the Soviet "Meteor-3" satellite.

The putsch forced the American specialists who developed the TOMS instrument for mapping our planet's ozone layer to leave the Soviet Union immediately. Craig Covault, editor of the well-known American journal AVIATION WEEK & SPACE TECHNOLOGY who was in our country as a guest of IZVESTIYA, also had to leave the USSR under emergency conditions. We had been with him at the Plesetsk cosmodrome and we were heartened by the successful start of this major Soviet-American space program.

Sixteen years had passed between the "Apollo-Soyuz" flight and this major new joint project. Soviet and American scientists, engineers, and workers had spent three years laboring to realize this project—the first such after many years of cool relations between our countries. The military coup—if it had been successful—would have derailed all of this, as well as the plans for future space cooperation. This and many other things besides. Our country would have been in scientific and economic isolation from the entire civilized world.

The American specialists left our country with bitterness. But in order that the many years of effort would not be lost and to leave some hope for the future they permitted our specialists to work independently with the American TOMS instrument.

And so the ozone patrol above our planet has successfully started to operate. We were informed by V.I. Adasko, technical director of the project for the Soviet side and director of the All-Union Scientific Research Institute of Electromechanics, that good quality telemetry data is being received in the Soviet Union and in the U.S. The U.S. has obtained the first maps of the ozone layer. Now the entire international community will obtain precise data on the condition of the ozone layer which protects all living things on our planet from the harmful ultraviolet radiation of the sun.

## Residents Interviewed at Plesetsk Cosmodrome

*OW2908065991 Moscow Central Television First Program and Orbita Networks in Russian 1900 GMT 27 Aug 91*

[Video report by V. Bogomolov; from the "Utro" program]

[Text] It is morning and the city is quiet. Incidentally, it is always quiet in this city; after all, it is called Mirnyy

[Peaceful]. The first people to appear shortly after sunrise are dog owners and those concerned with their health, and then those who are hurrying to work. The majority here travel to work on the train—or motovoz as it is called here through habit, although they are really ordinary rail cars. Here is a mother taking her daughter to the kindergarten before she also is to leave on the train. The city is still empty. Passersby appear at about 0800. What troubles the people of the city, which is built next to, and because of, the Plesetsk Cosmodrome? [Video shows early morning walkers, military and civilian commuters hurrying to catch the train or go to school then cuts to show Bogomolov's interviewing various people]

[Unidentified teacher] Today my concern is to spend this last day in the forest with my son.

[Bogomolov] Is he an officer?

[Teacher] No, he is a soldier.

[Captain Akimov] I have no worries, in principle.

[Bogomolov] None? Everything is all right with you?

[Akimov] Everything is all right.

[Unidentified officer] I am concerned that everything at work will remain normal.

[Bogomolov] What do you mean?

[Officer] What I mean is that I am concerned about any violations of military discipline among personnel.

[Bogomolov] What is your biggest worry this morning?

[Unidentified woman] That everything is all right with work. Chaos in the shops is probably worse. Generally, while we are at work, everything is sold.

[Teacher] Although this is a city for officers whose work is complex, compared to other cities, the situation in Mirnyy regarding the provision of food products and goods is rather worse than I expected.

[Gerasimova, corespondent for the teachers' newspaper] Everything is all right with me, although I am in doubt as to whether I can get to the launch today. [Video shows the Plesetsk Cosmodrome with a crowd of civilians, a rocket on the launch pad, people setting up cameras, a rocket being railed out of a hangar, brief distant shot of a launch]

[Bogomolov] It is not hard see the launch, even from the city, if one knows the time of the launch. If Plesetsk, the busiest cosmodrome on earth, invites specialists from NASA from the United States, for at least one viewing of a launch, then, as it is said, God himself decreed that Soviet journalists be permitted to view a space launch. So the morning that we filmed this report there was a [word indistinct] rocket launch. Such was the morning in Mirnyy.

## Space Personnel Concerned About Future of Program

*PM0209111391 Moscow Central Television First Program Network in Russian 1800 GMT 23 Aug 91*

[From the "Vremya" newscast: Report by A. Gerasimov and B. Antsiferov, from the flight control center]

[Text] To what extent are politics and space research linked? This is the theme of a report by our correspondent who was at the Flight Control Center last night for the docking of the Progress M-9 cargo craft and the Mir orbital station.

[Gerasimov] Every docking is followed with bated breath by everyone gathered at the Flight Control Center. After all, the not very smooth dockings of manned and cargo spacecraft modules are by no means forgotten. For instance, the Progress M-7 nearly crashed into the station at the beginning of the year.

However, the concerns of the team of specialists gathered in the control room are of a different kind today. The space sector is after all a component of the military-industrial complex whose leaders were the organizers of the putsch. And now the engineers and scientists are quite naturally afraid that the vast intellectual and technological potential of space science, a potential built up over the decades by people who were as far removed from plots and putsches as the Progress M-9 craft, might be dissipated during the upcoming reorganization of the military-industrial complex. Incidentally, no one questions the need for this reorganization.

As for the the Progress M-9, it docked successfully, delivering purely civilian cargo—scientific equipment for the upcoming Soviet-Austrian flight, fuel, food, and water.

## Increased Funding for Space Programs Urged

*PM0209153391 Moscow Central Television First Program Network in Russian 1800 GMT 29 Aug 91*

[From the "TV Inform" newscast: Report by A. Gerasimov and B. Antsiferov]

[Text] There's one more satellite in space. Our correspondent reports from Baykonur.

[Gerasimov] They say that our space sector is ruining the country. That we should feed our people first and launch rockets later. I'd like to put forward an idea that may sound seditious these days—we are making disgracefully poor use of our space technology. Today's launch is an example. India has paid around $20 million for the launch into orbit of its IRS-1B satellite. This is the fifth joint launch, and each one has been paid for in hard currency. But specialists say that the two Soviet space centers could handle far more. The Western restrictions on technological cooperation with the Soviet Union and the famous Cocom [Coordinating Committee for Multilateral Export Controls] lists are forcing the space goose

that lays the golden eggs to stand idle. Even one-shot contracts with industrial countries for manned missions can't paper over the huge cracks in a house that is, admittedly, not built yet. Understandably, the ban on cooperation with the Soviets was ideologically motivated, but it seems as though this obstacle crumbled a week ago. And if the Western countries enter into normal cooperation with us, space could be one of the few areas where the USSR has something to offer.

[Professor U.R. Rao, technical leader of the project] In three years' time we plan to launch another satellite in this series on a Soviet rocket. We hope that subsequent spacecraft will be placed in orbit by Indian equipment.

[Gerasimov] Even India—not one of the world's richest countries—has long since grasped the need to develop space research and invest adequate funds in it. Here's one detail: The satellite launched today should be operational for no less than four years—a guaranteed period longer than many Soviet spacecraft. The number of countries building their own launchers is growing apace. And if finance for the once-secret Ministry of General Machine Building is stopped, we could in future find ourselves permanently adrift of the rest of the world's space effort. Incidentally, if you look at the entire space budget, it works out to 10 kopeks per person per day. Is that too much?

## Uncertain Future of Soviet Space Program Discussed

*PM1009130791 Moscow Central Television First Program Network in Russian 1800 GMT 6 Sep 91*

[From the "TV Inform" newscast: Report by A. Gerasimov, V. Molchanov, B. Antsifirov, identified by caption]

[Text] [Announcer] The answer to the question Whose cosmonauts will be the first to walk on Mars? is: Most definitely not ours.

The funding of the Soviet space program is being cut back, and the situation is not likely to change for the better in the next few years. Incidentally, our meager resources can be put to better use. Rather than cutting projects which produce real returns, it is necessary to axe programs spawned by gigantomania.

[Cosmonaut Artsebarskiy speaking from Mir station] Radio hams are asking: Is it true that the Russians intend to sell off the Mir station? Since it is our home at the moment, we ask in turn: Does that include us?

[Gerasimov] This strange conversation stems from the uncertainty currently affecting our military-industrial complex.

It has been said that borders are not visible from space. This was true in the past. Today the borders of union republics are clearly discernible from the altitude of the orbital station. Kazakhstan, having announced that all union enterprises on its territory are being switched to republic jurisdiction, is about to launch its own—Kazakh—cosmonaut into orbit 2 October. Who owns Baykonur today? And whose property is the space station?

[Yu. P. Semenov, chief designer of "Energiya" Science and Production Association, identified by caption] It is necessary to determine who owns what. The situation as regards this is very vague. It is difficult today to say who owns the space station.

[Gerasimov] The space program, a union program in the past, could quite easily break up into several republic programs. In this situation, according to our information, the leadership of the military-industrial complex has seriously considered various options concerning the future fate of the Mir station, from selling it off to other space powers to scuttling it in the Pacific. The great theater of the absurd is breaking up into small studios. Its immediate participants [video shows space officials in conference] are discussing the space flight program for the coming year.

The Soviet space program, just like the armed forces—whose unity is being urged by Gorbachev today—were created by the whole union. When everything is up for grabs, those who are slow off the mark stand to lose.

[Announcer] All this is true, but our space program is far too precious to be carved up.